Distribution of Fish and Crayfish, and Measurement of Available Habitat in the Tualatin River Basin

Final Report 1999-2001

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ABSTRACT

Oregon Department of Fish and Wildlife (ODFW) conducted fish, habitat, and water quality surveys in sixteen tributaries of the lower Tualatin River as part of an effort to assess the biotic health of the watershed. We surveyed lower, middle, and upper reaches of most streams. Habitat surveys were conducted during the summers of 1999 and 2000, whereas fish and water quality surveys were conducted in summer, fall, winter and spring, 1999-2001. This project is a follow up to similar work conducted by the ODFW from 1993-95. Industrial and residential developments, as well as efforts to restore water quality and riparian habitat have continued since the 1993-95 surveys; therefore, periodic monitoring is needed to ensure that important habitat and existing populations of native fish are protected. Compared with the 1993-95 surveys the number of species collected decreased from 25 to 24 in the sixteen streams. The number of native species decreased from 13 to 11, whereas the number of introduced species increased from 12 to 13. The native reticulate sculpin *Cottus perplexus* remains the most abundant and widely distributed species throughout the basin. Introduced species contributed 18.3% of the total catch. Native and introduced species tolerant of habitat degradation accounted for 17.7% of the total catch, whereas native species sensitive to habitat degradation accounted for only 3.4% of the catch. Native and introduced species moderately or very tolerant of habitat degradation made up 96.6% of the total catch. Using the fish assemblage data collected, we calculated seasonal index of biotic integrity (IBI) scores for each stream reach sampled. Biotic integrity scores were used to evaluate the need for restoration and enhancement within Tualatin tributaries. When summer IBI scores were compared with those from the previous ODFW study, we found that all but four had increased. Of 154 biotic integrity scores calculated, none were considered acceptable, fifteen were marginally impaired, and the remaining scores were considered severely impaired. Habitat measurements changed little from previous surveys. Glides were the most common habitat type, and soil was the most common substrate. Of the streams surveyed, very little woody debris was found.

INTRODUCTION

The Tualatin River and its tributaries have been influenced by urban development brought about by increased population. In addition, industrial and agricultural practices have significantly affected the hydrology of the basin, modifying original channels and inundating natural floodplains (Shively 1993). The Oregon Department of Fish and Wildlife (ODFW) and Clean Water Services are concerned with the effects these changes have on water quality, fish habitat, and fish assemblages.

Extensive water quality investigations have been conducted in the Tualatin River Basin in recent years (Ervin et al. 1993); however, historic information on fish assemblages and aquatic habitat is scarce. ODFW has conducted occasional fish inventories, and The Oregon Fish Commission conducted fish and habitat surveys in 1958-59 (Willis et al. 1960). The occasional fish inventories were limited to single day, non-replicated samples in the mainstem Tualatin River, and emphasized salmonids. From 1993-95, ODFW conducted the first round of comprehensive fish and habitat surveys to establish a baseline condition of 15 streams in the Tualatin basin (Friesen and Ward 1996).

Residential, commercial, agricultural and forestry growth and development continue throughout the Tualatin River drainage. In contrast, preservation and restoration efforts for fish habitat have only just begun. Objectives of this study are to (1) seasonally sample throughout the Tualatin River drainage to evaluate the abundance and distribution of fish and crayfish species, (2) conduct aquatic inventory surveys in the Tualatin River drainage to collect information on available aquatic habitat and, (3) identify relationships between aquatic habitat characteristics and fish species abundance in the Tualatin River drainage. In this report we begin to compare the current status and condition of fish assemblages and habitat to that found during the 1993-95 surveys (Friesen et al. 1994, Ward 1995, Friesen and Ward 1996). These findings will help ODFW meet its goal to maintain optimum populations and distribution of the basin's fish resources to provide the greatest recreational, commercial, economic, and nonconsumptive benefits to future and present generations of Oregon citizens (ODFW 1993).

Study Area

The Tualatin River flows in an easterly direction from its headwaters in the Coast Range of Northwestern Oregon to its confluence with the Willamette River at river kilometer (RKm) 46.1 (Figure 1). The Tualatin River drainage is almost entirely within Washington County. Portions of the tributaries we sampled flow through the Portland metropolitan area growth boundary. These tributaries are generally low gradient, heavily silted streams that experience temperature extremes and seasonal flooding. The study area included seven primary and nine secondary tributaries of the Tualatin River (Figure 1). We identified and sampled 40 reaches within these streams. The reaches ranged in length from 215-2264 meters (Appendix A), and were located near the mouth, middle or headwaters of each stream. In addition we sampled three sites on the mainstem Tualatin River: Spring Hill pumping plant (RKm 90.1), the confluence of Fanno Creek (RKm 15.0), and the confluence of Gales Creek (RKm 90.9) (Appendix A).

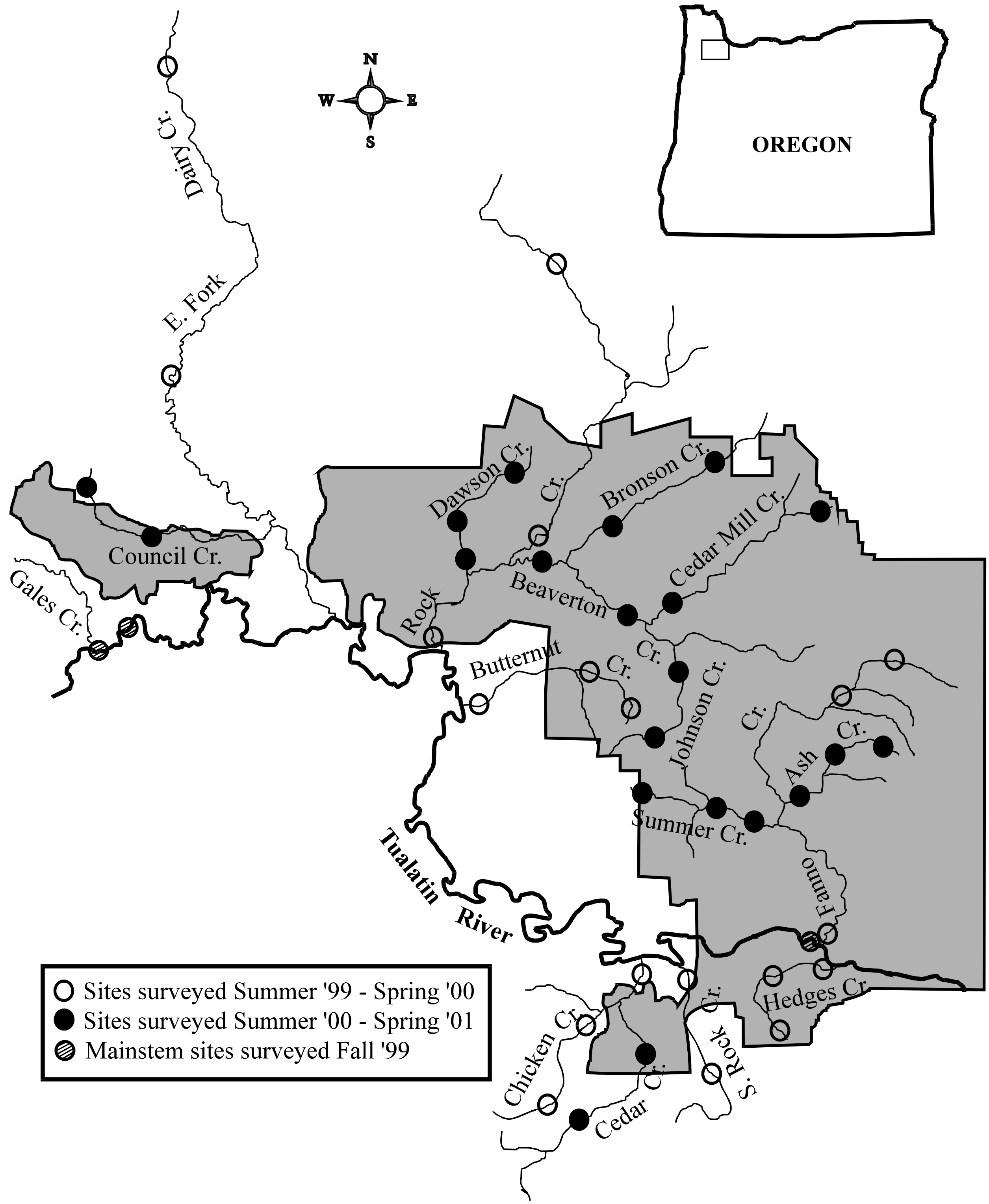

Figure 1. Tualatin River and tributaries surveyed, 1999-2001. Urban growth boundary of Washington County contained within shaded area.

METHODS

Fish Surveys

To estimate the relative abundance of fish species in each stream reach we used a three-pass removal method (Armour et al. 1983). A 100m section of each stream reach was selected based on accessibility, landowner approval, and how well the section represented the entire reach. A Smith-Root model-12 backpack electrofishing unit was used to conduct the surveys. Depending on water conductivity, the electrofishing unit was set to between 100 and 400 volts. Before starting we placed block nets at the lower and upper ends of the 100m sections to ensure population enclosure. We then made three successive passes starting at the downstream end of the stream section and working upstream. During each pass fish were netted and held in a holding tank until the completion of the pass. After each pass all fish collected were enumerated, identified to species, measured to the nearest millimeter (a maximum of 50 fish per species), and examined for any anomalies (parasites, wounds, or any other physical abnormalities). Before starting the next pass all fish were released below the downstream block net. If no salmonids were collected during the second pass, a third pass was not conducted. We also collected and enumerated all crayfish during each pass. Fish sampling was conducted once in each stream reach during summer, fall, winter, and spring.

We used an electrofishing boat to sample the mainstem Tualatin sites. These sites were sampled once in fall, 1999. A 900 second electrofishing pass was made to include the area above, below, and into the mouths of the tributaries if possible. During each pass all fish were collected. Fish were identified to species, examined for anomalies and released.

Habitat Surveys

During the summers of 1999 and 2000 we conducted aquatic habitat inventories within selected reaches of each of the sixteen primary tributaries. We used standardized protocols developed by ODFW to describe and quantify aquatic habitat. Methods used were developed by Bisson et al. (1982) and Hankin and Reeves (1988), and modified by Moore et al. (1997).

We surveyed three reaches of each stream, except South Rock, E. Dairy, Beaverton, Bronson, Cedar, Cedar Mill, Council and Johnson creeks, where only two reaches were surveyed (Figure 1). Reaches were selected to represent lower, middle, and upper sections of each stream. Reach lengths were determined by accessibility and landowner permission.

At the downstream end of each reach we described general physical habitat characteristics such as channel and valley form, vegetation class, land use, water temperature and stream flow. Each reach was further divided into habitat units such as pool, riffle, glide, etc. For each habitat unit we measured length, width, and depth. Unit length was limited to 100m for long stretches of homogeneous habitat. Within each habitat unit we visually estimated the substrate composition, percent actively eroding bank, and percent undercut bank. Using a clinometer we measured the degree of slope and percentage of shade within each habitat unit. We also noted habitat features such as beaver activity, culverts, and possible fish passage barriers.

Every habitat unit was given a woody debris rating depending on wood composition as it related to fish habitat. A rating of one to five was given, with one being little or no wood, and five being large amounts of wood creating cover and refuge. In addition, we noted the configuration, type, location, and size of root wads and pieces of wood measuring at least 1.5-3.0 cm in width and 3m in length.

Water Quality

Within each reach we selected a site with representative characteristics of the entire reach and collected a set of water quality measurements. Water quality measurements were taken once each season concurrent with fish surveys. Measurements taken were pH, turbidity, dissolved oxygen, temperature, water velocity, conductivity, salinity, and total dissolved solids. Water quality was collected on mainstem sites concurrent with boat electrofishing.

Index of Biotic Integrity

The index of biotic integrity (Karr et al. 1986) is a commonly used tool for assessing the biological integrity of streams. The IBI consists of a numerical score calculated from field survey data. A set of scoring criteria based on fish assemblage characteristics is used to calculate the biotic integrity score (Table 1). We used the IBI developed and tested by Hughes et al. (1998) for wadeable streams in the Willamette Valley. We slightly modified the IBI for use with Tualatin streams. Hughes et al. (1998) includes a “native top carnivore” metric as one of three trophic guild measurements. Species that we found in Tualatin streams listed as native top carnivores by Hughes et al. (1998) were cutthroat trout, rainbow trout, and torrent sculpin. Since these species are usually carnivorous only at larger sizes and few were captured in our surveys, the native top carnivore metric was dropped from our IBI. Other metrics and their scoring criteria remained unchanged. Because the IBI developed by Hughes only included first through third order streams, we included fourth order streams in the same scoring category as second and third order streams. Continuous scoring of 0.0-10.0 for individual metrics and 0-100 for the IBI score was used.

An IBI score was calculated for each seasonal fish survey. Mean IBI values were determined for seasons, streams, and reaches. Biotic integrity was judged as acceptable (≥75), marginally impaired (51-74), and severely impaired (≤50) Hughes et al. (1998). We assigned an IBI score of 0.0 to those reaches that contained no fish. Because the methods used to calculate index of biotic integrity scores have been modified since the 1993-95 ODFW study, we recalculated IBI scores using 1993-95 data using the current methods. Since only summer IBI scores were calculated in the 1993-95 ODFW study, we only used summer IBI scores to make comparisons between studies.

We used Spearman correlation (Zar 1984) to evaluate the correlation between habitat data and seasonal and mean IBI scores for each reach. Unlike habitat sampling, water quality measurements were taken seasonally, for this reason we used seasonal water quality data with seasonal IBI scores when determining correlation. We used a decision level of $P \leq 0.05$ to determine statistical significance.

Table 1. Scoring criteria for IBI metrics used for Tualatin urban streams. Raw data values at low (and lower) end of the ranges are scored as zero; those at the high (and higher) end are scored as 10; scores for intermediate values are calculated by dividing the raw value by the score range. Modified from Hughes et al. (1998).

	Raw values	
Metric	Stream order 1	Stream orders 2-4
Taxonomic richness		
Number of native families	0-4	0-7
Number of native species	0-5	0-11
Habitat guilds		
Number of native benthic species	0-3	0-7
Number of native water column species	0-2	0-4
Number of hider species	0-4	0-4
Number of sensitive species	0-2	0-5
Number of native non-guarding lithophil nester species[a]	0-3	0-3
Percent tolerant individuals	10-0	10-0
Trophic guilds		
Percent filter-feeding individuals	0-10	0-10
Percent omnivores	10-0	10-0
Individual health and abundance		
Percent of target species that include lunkers[b]	0-100	0-100
Percent individuals with anomalies	2-0	2-0

[a]Species that create nests in gravel or cobble substrate.

[b]Lunkers are relatively old, large individuals of the following species and sizes (fork length): prickly sculpin (100 mm), torrent sculpin (100 mm), rainbow trout (300 mm), cutthroat trout (250 mm), chiselmouth (300 mm), northern pikeminnow (300 mm), and largescale sucker (300 mm).

RESULTS

Fish Surveys

We conducted 154 electrofishing surveys in 16 streams during summer, fall, winter, and spring, 1999-2001. A total of 18,075 fish were collected representing 24 species and 13 families (Table 2; Appendix B). Number of individual fish collected was highest in Butternut Creek (1,595). We found the most species (14) in Butternut and S. Rock creeks. Reticulate sculpin comprised the greatest percent of our total catch (57.8%), followed by fathead minnow (7.4%), redside shiner (6.9%), and threespine stickleback (6.5%). Introduced species contributed 18.3% of the total catch, with fathead minnow being the most numerous (7.4%). Upper reaches contained more salmonids than other reaches, whereas lower reaches contained more stickleback and lamprey (Figure 2). Centrarchids and mosquitofish were most numerous in the middle reaches.

Species tolerant of warm temperatures, organic pollution, and sediment accounted for 25.6% of the total catch (Table 2), with the majority of these being fathead minnows and threespine stickleback. The only species sensitive to degraded habitat were salmonids (3.4%), with the majority of these being cutthroat trout (3.0%). Species considered intermediate in their response to degraded habitat comprised 70.9% of the catch, with the majority of these being reticulate sculpin.

The majority of the fish collected were insectivores (Table 2). The few omnivores included goldfish, carp, fathead minnows, and largescale suckers. Piscivorous species included pacific lamprey, largemouth bass, warmouth, yellow perch and torrent sculpin

Fish with anomalies were very rare and comprised only 0.8% of the total catch (Table 3). Most of the anomalies were in the form of parasites and were found primarily during spring sampling. Other anomalies included fin damage, scars, and other deformities. Anomalies were most common in reaches of North Rock and Fanno creeks, and least common in Dairy and Hedges creeks.

We counted the most crayfish (53) in lower Summer Creek, but found none in middle Chicken, middle Hedges, and upper S. Rock creeks (Appendix B). The majority of crayfish were seen in summer (158), followed by fall (79), and spring (53). Only five crayfish were counted during winter sampling.

We found a total of 11 species during Tualatin mainstem sampling (Table 4). Largescale sucker was the most abundant species, followed by cutthroat trout and largemouth bass. With the exception of salmonids, all species collected were moderately to very tolerant to habitat degradation.

Table 2. Fish collected in 40 reaches of 16 tributaries of the Tualatin River in summer, fall, winter, and spring 1999-2001. Relative tolerance and trophic group classifications from Zaroban et al. (1999).

Family, Species	Relative tolerance	Adult trophic group	Percent of Catch	No. of streams (reaches)
Petromyzontidae				
Western Brook lamprey *Lampetra richardsoni*	Intermediate	--[a]	1.93	13(25)
Pacific lamprey *Lampetra tridentata*	Intermediate	Piscivore	0.06	4(4)
Unidentified lamprey *Lampetra* spp.	Intermediate	--	0.07	5(7)
Salmonidae				
Unidentified Salmonidae	Sensitive	Insectivore	0.08	2(3)
Cutthroat trout *Oncorhynchus clarkii*	Sensitive	Insectivore	2.97	13(20)
Rainbow trout *Oncorhynchus mykiss*	Sensitive	Insectivore	0.37	8(8)
Cyprinidae				
Redside shiner *Richardsonius balteatus*	Intermediate	Insectivore	6.90	13(26)
Speckled dace *Rinichthys osculus*	Intermediate	Insectivore	3.62	9(15)
Goldfish *Carassius auratus*[b]	Tolerant	Omnivore	0.06	3(4)
Common carp *Cyprinus carpio*[b]	Tolerant	Omnivore	0.01	2(2)
Fathead Minnow *Pimephales promelas*[b]	Tolerant	Omnivore	7.36	7(11)
Catostomidae				
Largescale sucker *Catostomus macrocheilus*	Tolerant	Omnivore	0.53	11(16)
Ictaluridae[c]				
Brown bullhead *Amerius nebulosus*	Tolerant	Insectivore	0.21	6(7)
Yellow bullhead *Amerius natalis*	Tolerant	Insectivore	0.66	3(4)
Poeciliidae[c]				
Mosquitofish *Gambusia affinis*	Tolerant	Insectivore	5.90	13(21)
Gasterosteidae				
Threespine stickleback *Gasterosteus aculeatus*	Tolerant	Insectivore	6.81	12(21)
Centrarchidae[c]				
Unidentified *Lepomis* spp.	Tolerant		0.46	2(3)
Bluegill *Lepomis macrochirus*	Tolerant	Insectivore	1.58	12(16)
Pumpkinseed *Lepomis gibbosus*	Tolerant	Insectivore	1.36	5(7)
Warmouth *Lepomis gulosus*	Tolerant	Piscivore	0.02	2(2)
Largemouth bass *Micropterus salmoides*	Tolerant	Piscivore	0.59	11(14)
White Crappie *Promoxis annularis*	Tolerant	Insectivore	0.01	1(1)
Black Crappie *Promoxis nigromaculatus*	Tolerant	Insectivore	0.01	1(1)
Percidae[c]				
Yellow perch *Perca flavescens*	Intermediate	Piscivore	0.02	1(1)
Cottidae				
Unidentified *Cottus* spp.	--	Insectivore	0.01	1(1)
Reticulate sculpin *Cottus perplexus*	Intermediate	Insectivore	57.81	16(39)
Torrent sculpin *Cottus rhotheus*	Intermediate	Piscivore	0.51	1(1)
Prickly sculpin *Cottus asper*	Intermediate	Insectivore	0.02	2(2)

[a] Adults do not feed

[b] Introduced species

[c] Introduced family

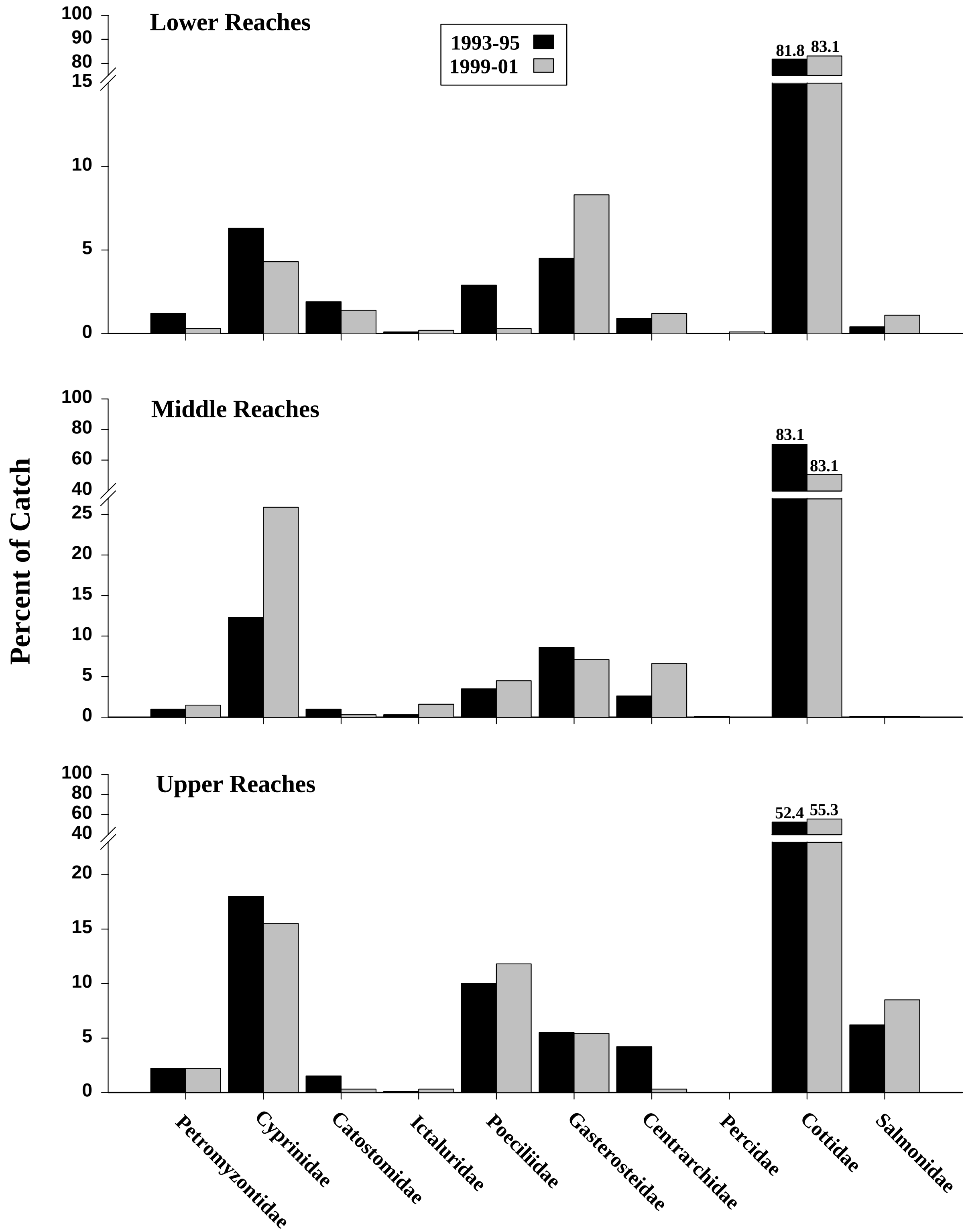

Figure 2. Family composition of fish collected in Tualatin River tributaries, 1993-95 and 1999-2001.

Table 3. Anomalies found in fish collected from sixteen tributaries of the Tualatin River, 1999-2001.

Stream, reach	Anomalies		
	Number of fish (% of catch)	Number with parasites	Number with deformities
Butternut			
Lower	1 (0.5)	0	1
Middle	1 (0.1)	0	1
Upper	5 (1.1)	5	0
Chicken			
Lower	14 (2.5)	10	4
Middle	6 (1.4)	6	0
Upper	3 (1.0)	2	1
Dairy			
Middle	0 (0.0)	0	0
Upper	4 (0.6)	0	4
Fanno			
Lower	9 (3.5)	8	1
Middle	29 (3.7)	25	2
Upper	0 (0.0)	0	0
Hedges			
Lower	1 (0.1)	0	1
Middle	3 (1.0)	2	1
Upper	0 (0.0)	0	0
N. Rock			
Lower	0 (0.0)	0	0
Middle	13 (5.0)	10	3
Upper	1 (0.3)	1	0
S. Rock			
Middle	9 (1.5)	3	6
Upper	2 (1.5)	1	1

Table 3. (Continued). Anomalies found in fish collected from sixteen tributaries of the Tualatin River, 1999-2001.

Stream, reach	Anomalies		
	Number of fish (% of catch)	Number with parasites	Number with deformities
Ash			
Lower	0(0.0)	0	0
Middle	1(0.1)	0	1
Upper	0(0.0)	0	0
Beaverton			
Lower	3(1.3)	1	2
Middle	1(0.2)	1	0
Bronson			
Lower	1(0.3)	0	1
Middle	1(0.3)	0	1
Cedar			
Middle	3(1.1)	2	1
Upper	5(0.9)	4	1
Cedar Mill			
Middle	6(0.7)	2	4
Upper	1(0.2)	0	1
Council			
Middle	3(2.1)	3	0
Upper	0(0.0))	0	0
Dawson			
Lower	3(1.4)	3	0
Middle	3(1.2)	0	3
Upper	1(0.3)	1	0
Johnson			
Middle	1(0.5)	0	1
Upper	0(0.0)	0	0
Summer			
Lower	5(0.5)	4	1
Middle	7(0.4)	1	6
Upper	3(0.4)	0	3

Table 4. Fish species caught at the three mainstem Tualatin River sites, fall 1999.

Species	Spring Hill pumping station	Mouth of Gales Creek	Mouth of Fanno Creek
Salmonidae			
Unidentified Salmonid	0	5	0
Cutthroat trout	0	7	0
Coho salmon	0	1	0
Chinook salmon	2	1	0
Cyprinidae			
Redside shiner	0	0	0
Common carp	1	0	6
Catostomidae			
Largescale sucker	5	26	2
Centrarchidae			
Largemouth Bass	2	0	6
Pumpkinseed	0	0	1
Cottidae			
Unidentified sculpin	0	0	1
Percidae			
Yellow perch	0	0	7

Habitat Surveys

Glides (characterized by uniform depth and flow) were the most common habitat type in all but one lower reach, all but two middle reaches and in 10 of 15 upper reaches (Figure 3; Appendix C). Riffles (faster flow and higher gradient) were the next most common habitat type, being found primarily in upper reaches. Pools (low gradient, non-uniform depth) were most common in lower reaches. The “Other” category consisted mostly of steps (short units with abrupt, discrete breaks in channel gradient), and was most abundant in upper reaches. Only two reaches (upper Hedges and upper Dairy) had any rapids (Figure 3).

Soil, which consisted of silt/organic material and sand, was the most abundant substrate type and dominated the lower and middle reaches (Figure 3; Appendix C). Rock, a combination of gravel and cobble, was most common in upper reaches. Boulder and bedrock substrate types were rare and were also found mostly in upper reaches.

Actively eroding banks were most common in lower and middle reaches (Figure 3), and comprised more than 50% of the bank in 7 of 40 reaches. For each of these seven reaches, at least 80% of substrate consisted of soil. Undercut banks comprised <20% of the total bank in all

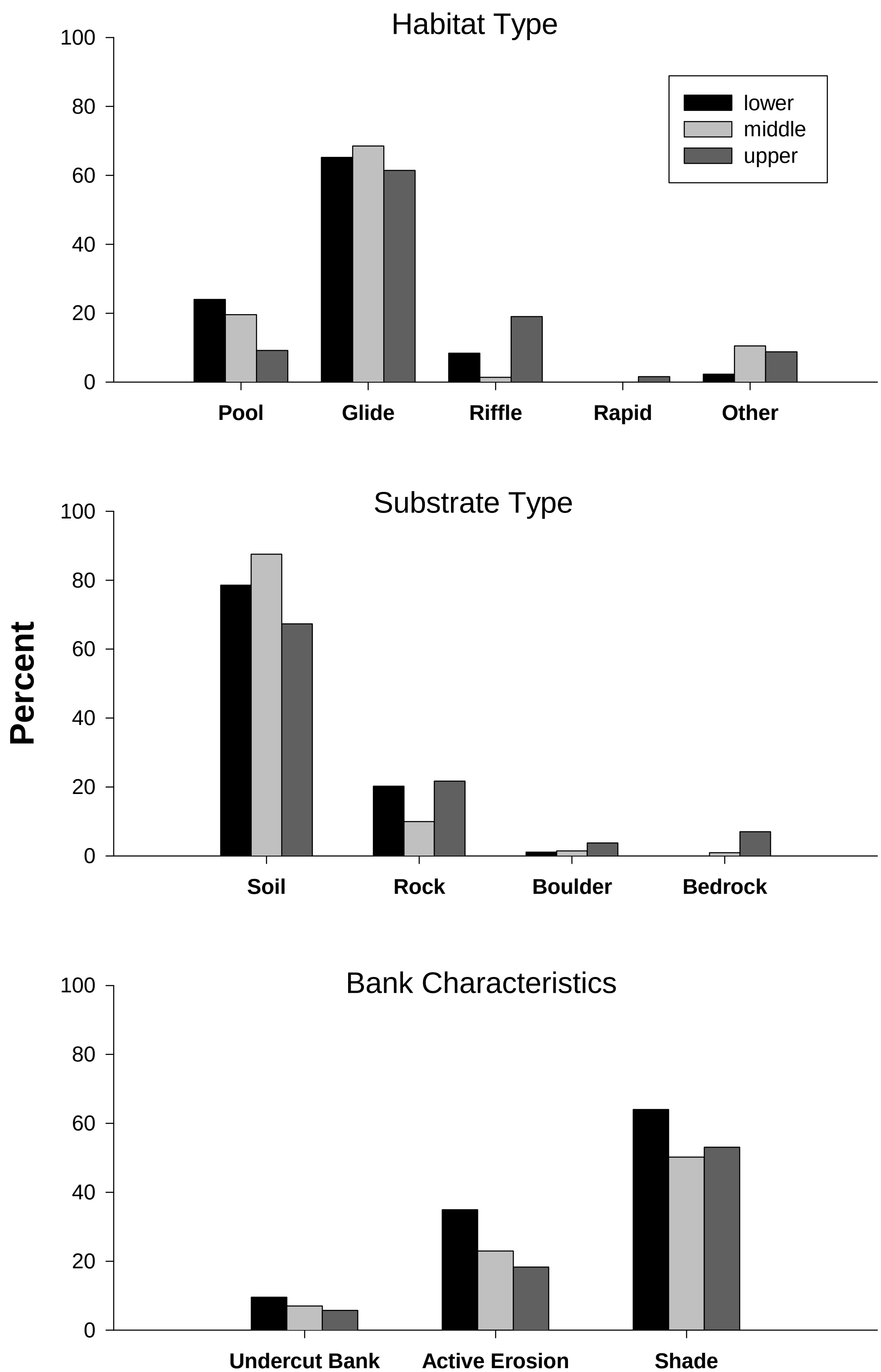

Figure 3. Percent habitat characteristics of lower Tualatin River tributaries, 1999-2001.

reaches except three (lower Butternut, lower Dawson and middle S. Rock). Shade exceeded 50 % in most reaches; however, percent shade was higher in lower (64%) and upper (53%) reaches than in middle reaches (50%) (Figure 3). The mean index of woody debris was low (<2.0) for all streams and reaches.

Water Quality

Water quality varied among streams and seasons (Appendix D). Highest water temperatures were found during summer sampling in middle Summer and upper Council creeks, and lowest temperatures were found during winter sampling in the upper reaches of Bronson and South Rock creeks. Dissolved oxygen levels were generally higher in streams with lower water temperatures. Water temperatures generally dropped during fall and winter, and rose again in spring. We found moderate variation in pH among streams and seasons (range 5.0-9.3). The water quality parameters on the mainstem sites were comparable to those from lower reaches of tributaries in fall (Table 5).

Index of Biotic Integrity

Index of biotic integrity scores are summarized in Table 6. IBI scores are shown by reach and season, seasonal mean by reach, and stream mean. The mean IBI score for all reaches combined was 35.5, and varied from 31.5 during winter to 38.9 during summer. Upper Johnson Creek had the lowest (8.9) mean IBI score; and upper East Fork Dairy Creek had the highest (50.9) mean IBI score. Scores were highly variable for some reaches and seasons, but remained consistent for others. Middle Cedar Mill Creek, for example, ranged from 7.2 during winter to 46.1 during spring, whereas middle Butternut Creek only ranged from 34.6 in spring to 35.6 in summer and winter.

We observed the highest seasonal IBI scores during summer sampling in lower Dawson (64.5) and during spring sampling middle Chicken (59.9). The lowest seasonal reach IBI scores were observed during summer, fall, and spring in upper Johnson Creek (0.0) and during winter sampling in upper Summer Creek (0.8). Because no fish were caught in upper Johnson during summer, fall, and spring sampling, it was given an IBI score of 0.0 for each of those seasons.

When compared with the previous ODFW study, we observed an increase in the 1999-2001 summer IBI scores in 30 of 34 stream reaches (Table 7). Reaches in which IBI scores decreased from the previous study were; lower Beaverton, lower Bronson, upper Hedges, and upper Johnson. Lower Summer creek was the only reach in which the IBI score remained unchanged.

Statistically significant correlations were rare among habitat characteristics and seasonal mean IBI scores (Table 8). Of the 60 individual correlations calculated, only four significant relationships were found. Significant positive correlations were found among fall IBI scores and mean percent shading (P=0.002), mean wood rating (P=0.0005), percent gravel or cobble substrate (P=0.01), and among spring IBI scores and percent gravel or cobble substrate (P=0.02).

Table 5. Water quality measurements at the three mainstem Tualatin River sampling sites, fall 1999.

Water Quality	Spring Hill pumping station	Mouth of Gales Creek	Mouth of Fanno Creek
Temperature (°C)	14.3	14.4	13.9
Dissolved Oxygen (mg/L)	9.4	9.6	5.1
Salinity (ppt)	0.0	0.0	0.1
Total Dissolved Solids (mg/L)	33.5	36.6	91.6
Turbidity (NTU)	6.1	6.2	4.4
Mean Velocity (m/s)	0.0[a]	2.5	1.8

[a]Spring Hill pumping plant is located in a backwater channel of the Tualatin River.

Table 6. Index of biotic integrity (IBI) scores for Tualatin River tributary stream reaches, 1999-2001. Scores were considered acceptable, marginally impaired, or severely impaired if they were ≥75, 51-74, or ≤50, respectively (Hughes et al. 1998). NS = no survey.

		IBI score					
Stream	Reach	Summer	Fall	Winter	Spring	Mean	Stream Mean
Butternut	Lower	37.0	37.7	25.0	44.2	36.0	
	Middle	35.6	34.9	35.6	34.6	35.2	
	Upper	35.6	35.6	42.8	29.0	35.8	35.7
Chicken	Lower	51.6	34.9	33.8	34.9	38.8	
	Middle	48.1	50.1	32.2	59.9	47.6	
	Upper	51.2	51.8	36.6	44.8	46.1	44.2
E. Dairy	Middle	45.4	28.1	NS	40.3	37.9	
	Upper	50.4	50.4	44.3	58.3	50.9	44.4
Fanno	Lower	42.7	30.7	NS	51.7	41.7	
	Middle	46.0	37.0	49.1	49.2	45.3	
	Upper	47.5	40.6	41.1	50.2	44.9	44.0
Hedges	Lower	23.8	23.8	40.6	34.4	30.7	
	Middle	23.8	23.8	30.1	20.7	24.6	
	Upper	31.5	31.5	51.1	40.9	38.8	31.3
N. Rock	Lower	42.2	46.6	NS	38.5	42.4	
	Middle	36.8	NS	NS	41.4	39.1	
	Upper	44.5	45.1	41.1	36.7	41.9	41.1
S. Rock	Middle	44.7	35.9	40.1	47.8	42.1	
	Upper	22.6	27.9	25.1	20.7	24.1	33.1

Table 6. Continued. Index of biotic integrity (IBI) scores for Tualatin River tributary stream reaches, 1999-2001. Scores were considered acceptable, marginally impaired, or severely impaired if they were ≥75, 51-74, or ≤50, respectively (Hughes et al. 1998). NS = no survey.

		IBI score					
Stream	Reach	Summer	Fall	Winter	Spring	Mean	Stream Mean
Ash	Lower	39.7	25.2	14.6	29.2	27.2	
	Middle	30.5	32.2	33.3	32.2	32.1	
	Upper	41.1	43.9	39.4	43.9	42.1	33.8
Beaverton	Lower	32.2	30.7	17.3	28.3	27.1	
	Middle	40.4	38.3	33.7	47.0	39.9	33.5
Bronson	Lower	32.3	37.1	25.6	45.2	35.1	
	Middle	54.3	38.3	41.9	49.0	45.9	40.5
Cedar	Middle	41.8	47.4	21.2	21.7	33.0	
	Upper	40.7	31.4	41.0	42.5	38.9	36.0
Cedar Mill	Middle	45.5	28.9	7.2	46.1	31.9	
	Upper	53.0	33.9	36.2	32.3	38.9	35.4
Council	Middle	25.8	29.8	38.3	23.8	29.4	
	Upper	37.6	35.6	16.2	39.7	32.3	30.9
Dawson	Lower	64.5	38.1	39.4	38.1	45.0	
	Middle	39.4	47.6	36.9	45.7	42.4	
	Upper	39.7	29.0	36.2	53.9	39.7	42.4
Johnson	Middle	29.8	29.8	27.9	21.1	27.2	
	Upper	0.0	0.0	35.6	0.0	8.9	18.0
Summer	Lower	36.2	41.6	10.3	40.2	32.1	
	Middle	28.0	28.0	12.9	15.6	21.1	
	Upper	16.7	20.5	0.8	8.3	11.6	21.6

Table 7. Summer index of biotic integrity scores from 1999-2001 and 1993-1995 ODFW surveys.

		Summer IBI Score		
Stream	Reach	1993-1995	1999-2001	Change
Ash	Lower	24.6	39.7	15.1
Ash	Middle	28.4	30.5	2.1
Ash	Upper	23.2	41.1	17.9
Beaverton	Lower	36.8	32.2	-4.6
Beaverton	Middle	29.3	40.4	11.1
Bronson	Lower	35.1	32.3	-2.8
Bronson	Middle	27.9	54.3	26.4
Butternut	Lower	20.1	37.0	16.9
Butternut	Middle	34.3	35.6	1.3
Butternut	Upper	31.5	35.6	4.1
Cedar	Middle	32.4	45.5	13.1
Cedar	Upper	41.3	53.0	11.7
Cedar Mill	Middle	24.0	41.8	17.8
Cedar Mill	Upper	28.2	40.7	12.5
Chicken	Lower	44.4	51.6	7.2
Chicken	Middle	47.4	48.1	0.7
Chicken	Upper	28.3	51.2	22.9
Council[a]	Middle	--	25.8	--
Council[a]	Upper	--	37.6	--
Dawson	Lower	56.2	64.5	8.3
Dawson	Middle	--[b]	39.4	--
Dawson	Upper	38.5	39.7	1.2
E. Dairy	Middle	34.9	45.4	10.5
E. Dairy	Upper	40.4	50.4	10.0
Fanno	Lower	36.4	42.7	6.3
Fanno	Middle	44.2	46.0	1.8
Fanno	Upper	33.0	47.5	14.5
Hedges	Lower	--[b]	23.8	--
Hedges	Middle	16.7	23.8	7.1
Hedges	Upper	40.1	31.5	-8.6
Johnson	Middle	--[b]	29.8	--
Johnson	Upper	26.0	0.0	-26.0
N. Rock	Lower	34.8	42.2	7.4
N. Rock	Middle	35.1	36.8	1.7
N. Rock	Upper	--[b]	44.5	--
S. Rock	Middle	36.1	44.7	8.6
S. Rock	Upper	20.7	22.6	1.9
Summer	Lower	36.2	36.2	0.0
Summer	Middle	18.6	28.0	9.4
Summer	Upper	10.4	16.7	6.3

[a]Stream not included in 1993-95 ODFW study.
[b]IBI not calculated in 1993-95 ODFW study.

Table 8. Spearman correlation coefficients for comparisons of index of biotic integrity (IBI) scores with habitat data summarized for all stream reaches, 1999-2001. Statistically significant relationships (P<0.05) are denoted with an asterisk (*).

	IBI				
Habitat variable	Summer	Fall	Winter	Spring	Mean
% of units with eroding banks	0.04	-0.03	0.12	0.17	0.05
Mean pool depth (m)	-0.11	0.00	-0.25	-0.12	-0.07
Mean % shading	-0.00	0.41*	0.18	0.05	0.03
Number of boulders	-0.15	-0.06	0.08	0.09	0.05
Mean % undercut bank	-0.00	0.06	0.03	0.12	0.00
Mean wood rating	-0.13	0.33*	0.07	-0.6	-0.12
% of units with wood rating >2	-0.06	0.17	0.20	0.00	0.07
% silt or sand substrate	-0.02	-0.32*	0.02	-0.18	-0.12
% gravel or cobble substrate	0.14	0.48*	0.14	0.32*	0.23
% surface area as fast water units (m^2)	0.04	-0.19	-0.23	0.03	-0.01
% surface area as glides (m^2)	0.07	0.25	-0.13	-0.02	0.11
% surface area as pools (m^2)	-0.05	-0.12	0.17	-0.11	-0.16

The only significant negative relationship found was between spring IBI scores and percent silt or sand substrate.

We found more significant correlations among water quality characteristics and seasonal IBI scores (Table 9). Of the 35 individual correlations calculated, we found eight significant relationships. Summer IBI scores were positively correlated with dissolved oxygen levels (*P*=0.046) and negatively correlated with temperature (*P*=0.00). Winter IBI scores were negatively correlated with conductivity (*P*=0.02), and total dissolved solids (*P*=0.02). Mean IBI scores were correlated with percent oxygen saturation (*P*=0.002), dissolved oxygen (*P*=0.00), temperature (*P*=0.005), and water velocity (*P*=0.002).

DISCUSSION

Fish assemblages in tributaries of the lower Tualatin River have changed little since previous surveys in 1993-95 (Ward 1995). The number of species collected decreased from 25 to 24 in the sixteen streams. The number of native species decreased from 13 to 11, whereas the number of introduced species increased from 12 to 13. Native species undetected in this survey but found previously were coho salmon *O. kisutsch*, and northern pikeminnow *Ptychocheilus oregonensis*. Although considered native to the Willamette River basin, coho salmon were not historically abundant in the Tualatin River drainage. Hatchery releases of juvenile coho salmon into the Tualatin River drainage have recently been discontinued; therefore, absence of coho salmon from our collections is not surprising. The introduced goldfish was the only species found that was previously undetected.

The reticulate sculpin, found in all 16 streams surveyed, remains the most abundant and widely distributed fish in tributaries of the lower Tualatin River. We also found trout and western brook lamprey in 13 of the 16 streams surveyed, but in fewer reaches and in much lower abundance. We found trout in Hedges, Ash, and Bronson creeks, which were not seen during the previous surveys. Torrent sculpin were again found only in the upper reach of Dairy Creek. Pacific lamprey, previously found in all but two streams, were found only in reaches of Fanno, Chicken, Cedar Mill, and Cedar creeks, indicating a possible decline in their abundance. The large increase in the numbers of largescale suckers in lower Chicken Creek during spring may indicate the importance of this reach to spawning.

General habitat conditions remain similar to those found during the previous surveys (Friesen et al. 1994). Glides continue to be the dominant habitat type, and soil the dominant substrate type, especially in lower and middle stream reaches. The amount of shade has changed little; however, the amount of woody debris has decreased in most streams. This may be attributed to high flood conditions that have occurred since the previous surveys clearing away woody debris from the streams. Since pools created by large woody debris jams are preferred habitat for salmonid species (Bisson et al. 1988), streams with a low woody debris rating should be considered as candidate streams for enhancement projects involving the placement of large woody debris.

Table 9. Spearman correlation coefficients for comparisons of index of biotic integrity (IBI) scores with water quality variables in Tualatin River tributary stream reaches, 1999-2001. The "mean" column compares mean IBI score and mean water quality variable for all seasons combined. Strongly correlated variables (P<0.05) are denoted with an asterisk (*).

	IBI				
Water quality variable	Summer	Fall	Winter	Spring	Mean
Turbidity (NTU)[a]	-0.06	-0.03	0.03	-0.28	-0.27
Percent oxygen saturation	0.14	0.15	-0.01	0.23	0.47*
Dissolved oxygen (mg/L)	0.32*	0.25	0.18	0.23	0.54*
Temperature (°C)	-0.51*	-0.29	-0.05	-0.27	-0.43*
Water velocity (m/s)	0.31	0.11	0.29	0.28	0.47*
Conductivity (μS/cm)[b]	-0.17	-0.18	-0.38*	0.08	-0.15
Total dissolved solids (mg/L)	-0.17	-0.18	-0.38*	-0.01	-0.16

[a]nephelometric turbidity unit
[b]microSeimens/cc

The temperature limit to support salmonid spawning and rearing should not exceed 12.8°C, and any consistent temperatures above 20°C can have detrimental effects on cold-water species (DEQ 2000). None of the streams surveyed were found to be above lethal limits (range 4.2-19.0°C). No reaches during winter and 15 reaches during fall sampling were measured above 12.8°C. During spring and summer surveys, 12 and 36 reaches respectively were found to be above 12.8°C.

Dissolved oxygen levels above 11mg/L are required to support salmonid spawning and rearing and above 5.5mg/L to support warm water aquatic resources (DEQ 2000). Dissolved oxygen levels were higher than 11mg/L in 34 of 154 of our seasonal site surveys. Most dissolved oxygen levels above 11mg/L occurred during winter and spring. During summer surveys only six sites were above 11mg/L, and eight sites were below 5.5mg/L. Dissolved oxygen levels were below 5.5mg/L at ten sites during fall.

In general, stream pH levels fall primarily between the range of 6.5 and 8.5 (DEQ 2000). Of the 154 site surveys only 21 were found outside of this range. Twelve sites were lower than 6.5, and nine were higher than 8.5.

Of the 154 IBI scores we calculated none fell within the range to be considered acceptable, 15 were considered marginally impaired and the remaining IBI scores were considered severely impaired. When compared with those of the previous ODFW study, IBI scores have increased in the majority of the reaches surveyed. This increase in biotic integrity is most likely attributed to habitat preservation and enhancement efforts undertaken since the time of the previous study.

We suggest prioritizing aquatic habitat enhancement projects within Tualatin tributaries according to biotic integrity scores. This is similar to the methods used to prioritize habitat restoration in the earlier Tualatin tributaries study (Ward and Friesen 1995). Aquatic habitat in the vicinity of stream reaches with higher IBI scores should be protected and conserved. These reaches contain relatively healthy fish assemblages, and in general have a greater amount of quality aquatic habitat. Reaches with moderate and poor IBI scores should be considered for habitat restoration and enhancements projects. These reaches are more likely to benefit from habitat enhancement projects.

Due to the continued urban and rural growth within the Tualatin River basin, revisiting these stream reaches on a periodic basis is recommended. To ensure that the biotic integrity of Tualatin tributaries is preserved and maintained, future studies should be conducted and the findings compared with those of this and previous studies to determine the need for future aquatic habitat enhancement and preservation.

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APPENDIX A

Stream Reach Locations

Appendix Table A-1. Locations of habitat surveys conducted in 1999-2000. Fish surveys were conducted in a 100 meter section within each reach.

Stream	Reach	Location	Reach Length (meters)
Hedges	Lower	Mouth to Boones Ferry Road	574
	Middle	Teton Road to 108th Street	215
	Upper	105th Street to 489 meters upstream	492
Fanno	Lower	Mouth to Durham Road	2050
	Middle	Oregon Episcopal School to Oleson Road	1668
	Upper	39th Street to 404 meters downstream	559
S. Rock	Middle	Highway 99W to 300 meters upstream	311
	Upper	Tualatin-Sherwood Road to Oregon Street	650
Chicken	Lower	Mouth to 585 meters upstream	605
	Middle	Edy Road to 510 meters upstream	514
	Upper	Kruger Road to 285 meters upstream	762
Butternut	Lower	Mouth to River Road	358
	Middle	Butternut Park to 185th Street	651
	Upper	Farmington Road to Oak Street	341
N. Rock	Lower	Mouth to River Road	911
	Middle	Cornell Road to Evergreen Parkway	215
	Upper	Tributary crossing at Rock Creek Road to 400meters upstream	402
Dairy	Middle	Roy Road to railroad bridge	1005
	Upper	Greener Road to Little Bend Park	449

Appendix Table A-2. Locations of habitat surveys conducted in 2000-2001. Fish surveys were conducted in a 100 meter section within each reach.

Stream	Reach	Location	Reach Length (meters)
Cedar	Middle	Meineke Road to 599 meters upstream	605
	Upper	Rein Road to 400 meters downstream	405
Council	Middle	NW Martin Road to 1026 meters downstream	1026
	Upper	Highway 47 to upstream 1000 meters	1000
Summer	Lower	Mouth to Fowler Junior High School	1521
	Middle	121^{st} Street to 116^{th} Street	658
	Upper	135^{th} Street to Old Scholls Ferry Road	284
Ash	Lower	Mouth to Highway 217	878
	Middle	Locust Street to Metzger Park	576
	Upper	Taylors Ferry Road to 765 meters upstream	759
Dawson	Lower	Mouth to Baseline Road	623
	Middle	Brookwood Road to Cornell Road	845
	Upper	Airport Road to Shute Road	1038
Beaverton	Lower	Mouth to 216^{th} Street	1500
	Middle	185^{th} Street to 170^{th} Street	2264
Bronson	Lower	Cornell Road to Bronson Road	371
	Middle	Laidlaw Road to 445 meters downstream	498
Cedar Mill	Middle	Jenkins Road to 800 meters upstream	926
	Upper	113^{th} Street to 500 meters upstream	798
Johnson	Middle	Mouth to Division Street and 149^{th} Street	817
	Upper	170^{th} Street to 175^{th} and Riegert Road	443

Appendix Table A-3. Mainstem Tualatin River boat electrofishing sites sampled fall of 1999.

Site	Designation	River Kilometer (mile)
1	Spring Hill pumping station	90.1 (56.0)
2	Mouth of Gales Creek	90.9 (56.5)
3	Mouth of Fanno Creek	9.3 (15.0)

APPENDIX B

Fish Survey Data

Appendix Table B-1. Number of fish and crayfish collected in reaches of Tualatin River tributaries, summer 1999. L = lower reach, M = middle reach, and U = upper reach.

	Stream										
	Hedges			Fanno			S. Rock		Chicken		
Species	L	M	U	L	M	U	M	U	L	M	U
Western brook lamprey	0	0	0	8	1	1	9	0	7	1	11
Pacific lamprey	0	0	0	0	0	0	0	0	5	0	0
Unidentified lamprey	0	0	0	1	0	0	0	0	0	0	0
Cutthroat trout	0	0	0	0	6	6	0	0	19	9	18
Rainbow trout	0	0	0	0	0	0	1	0	0	0	0
Unidentified trout	0	0	0	0	0	0	0	0	0	0	0
Redside shiner	0	0	0	5	73	6	0	0	2	34	0
Speckled dace	0	0	0	2	0	0	0	0	0	0	0
Goldfish	0	0	0	0	0	0	0	0	0	0	0
Common carp	0	0	0	0	0	0	0	0	0	0	0
Fathead minnow	0	0	0	0	0	0	0	0	0	0	0
Largescale sucker	0	0	0	1	0	0	0	0	0	0	0
Brown bullhead	0	0	0	1	0	0	0	0	0	0	0
Yellow bullhead	0	0	0	0	0	0	0	0	0	0	0
Mosquitofish	0	71	0	0	7	1	0	8	0	0	0
Threespine stickleback	106	22	0	0	0	0	12	23	0	0	0
White crappie	0	0	0	0	0	0	0	0	0	0	0
Bluegill	0	0	0	0	0	0	0	0	0	0	0
Pumpkinseed	1	0	0	0	0	0	1	0	0	0	0
Warmouth	0	0	0	0	0	0	0	0	0	0	0
Largemouth bass	2	4	0	15	0	0	13	0	6	0	0
Unidentified *Lepomis*	0	0	0	0	0	0	0	0	0	0	0
Yellow perch	0	0	0	0	0	0	0	0	0	0	0
Reticulate sculpin	120	15	210	86	248	121	27	1	107	104	89
Torrent sculpin	0	0	0	0	0	0	0	0	0	0	0
Prickly sculpin	0	0	0	0	0	0	0	0	0	0	0
Unidentified sculpin	0	0	0	0	0	0	0	0	0	0	0
Crayfish	1	0	8	2	2	3	2	0	16	1	2

Appendix Table B-2. Number of fish and crayfish collected in reaches of Tualatin River tributaries, summer 1999. L = lower reach, M = middle reach, and U = upper reach.

	Stream							
	Butternut			N. Rock			Dairy	
Species	L	M	U	L	M	U	M	U
Western brook lamprey	6	0	0	11	3	2	5	1
Pacific lamprey	0	0	0	0	0	0	0	0
Unidentified lamprey	0	0	0	0	0	0	0	0
Cutthroat trout	0	0	0	3	0	19	1	132
Rainbow trout	0	0	0	0	0	0	0	16
Unidentified trout	0	0	0	0	0	0	0	0
Redside shiner	0	0	0	0	0	0	0	0
Speckled dace	0	7	58	0	0	0	0	0
Goldfish	0	0	0	0	0	0	0	0
Common carp	0	0	0	0	0	0	0	0
Fathead minnow	0	0	0	0	0	0	0	0
Largescale sucker	0	0	0	0	1	0	0	0
Brown bullhead	3	0	0	0	0	0	0	0
Yellow bullhead	0	0	0	0	0	0	0	0
Mosquitofish	1	29	0	0	3	0	3	0
Threespine stickleback	0	52	18	0	0	0	0	0
White crappie	0	0	0	0	0	0	0	0
Bluegill	0	0	0	5	0	0	0	0
Pumpkinseed	0	0	0	0	0	0	0	0
Warmouth	0	0	0	0	0	0	0	0
Largemouth bass	2	0	0	2	3	0	0	0
Unidentified *Lepomis*	0	0	0	0	0	0	0	0
Yellow perch	0	0	0	0	0	0	0	0
Reticulate sculpin	71	23	10	203	92	132	75	72
Torrent sculpin	0	0	0	0	0	0	0	32
Prickly sculpin	0	0	0	0	0	0	0	0
Unidentified sculpin	0	0	0	0	0	0	1	0
Crayfish	2	2	0	--	2	14	3	6

Appendix Table B-3. Number of fish and crayfish collected in reaches of Tualatin River tributaries, fall 1999. L = lower reach, M = middle reach, and U = upper reach.

	Stream										
	Hedges			Fanno			S. Rock		Chicken		
Species	L	M	U	L	M	U	M	U	L	M	U
Western brook lamprey	0	0	0	1	0	0	10	0	0	1	5
Pacific lamprey	0	0	0	0	0	0	0	0	0	0	0
Unidentified lamprey	0	0	0	0	1	0	0	0	0	0	0
Cutthroat trout	0	0	0	0	4	3	0	0	3	9	9
Rainbow trout	0	0	0	0	0	0	0	0	7	0	0
Unidentified trout	0	0	0	0	0	0	0	0	0	0	0
Redside shiner	0	0	0	0	36	1	0	1	0	48	0
Speckled dace	0	0	0	0	0	0	0	0	0	1	0
Goldfish	0	0	0	0	0	0	0	0	0	0	0
Common carp	0	0	0	0	0	0	0	0	0	0	0
Fathead minnow	0	0	0	0	0	0	0	0	0	0	0
Largescale sucker	0	0	0	0	0	0	0	2	0	0	0
Brown bullhead	0	0	0	0	0	0	0	0	0	0	0
Yellow bullhead	0	0	0	0	0	0	0	0	0	0	0
Mosquitofish	0	104	0	0	14	0	0	9	0	0	0
Threespine stickleback	138	2	0	0	0	0	15	58	0	0	0
White crappie	0	0	0	0	0	0	0	0	0	0	0
Bluegill	0	0	0	2	0	0	0	0	1	0	0
Pumpkinseed	0	0	0	0	0	0	2	0	2	0	0
Warmouth	0	0	0	0	0	0	0	0	0	0	0
Largemouth bass	1	0	0	2	0	0	0	0	1	0	0
Unidentified *Lepomis*	0	1	0	0	0	0	0	0	0	0	0
Yellow perch	0	0	0	0	0	0	0	0	0	0	0
Reticulate sculpin	71	2	82	53	150	36	132	19	39	62	35
Torrent sculpin	0	0	0	0	0	0	0	0	0	0	0
Prickly sculpin	0	0	0	0	0	0	0	0	0	0	0
Unidentified sculpin	0	0	0	0	0	0	0	0	0	0	0
Crayfish	0	0	1	8	0	3	1	0	0	5	7

Appendix Table B-4. Number of fish and crayfish collected in reaches of Tualatin River tributaries, fall 1999. L = lower reach, M = middle reach, and U = upper reach.

	Stream							
	Butternut			N. Rock			Dairy	
Species	L	M	U	L	M	U	M	U
Western brook lamprey	2	0	0	1	--	1	0	1
Pacific lamprey	0	0	0	0	--	0	0	0
Unidentified lamprey	0	0	0	0	--	0	0	0
Cutthroat trout	0	0	0	1	--	5	0	90
Rainbow trout	0	0	0	0	--	0	0	16
Unidentified trout	0	0	0	0	--	0	0	0
Redside shiner	0	0	0	0	--	0	0	0
Speckled dace	0	28	3	0	--	0	0	0
Goldfish	0	2	0	0	--	0	0	0
Common carp	0	0	0	0	--	0	0	0
Fathead minnow	0	0	0	0	--	0	0	0
Largescale sucker	0	0	0	0	--	0	0	0
Brown bullhead	0	0	0	0	--	0	0	0
Yellow bullhead	0	0	0	0	--	0	0	0
Mosquitofish	0	76	4	0	--	0	0	0
Threespine stickleback	0	99	6	0	--	0	0	0
White crappie	0	0	0	0	--	0	0	0
Bluegill	0	8	0	0	--	0	0	0
Pumpkinseed	0	0	0	0	--	0	0	0
Warmouth	0	0	0	0	--	0	0	0
Largemouth bass	1	0	0	0	--	0	0	0
Unidentified *Lepomis*	0	0	0	0	--	0	0	0
Yellow perch	0	0	0	0	--	0	0	0
Reticulate sculpin	28	29	8	24	--	44	22	41
Torrent sculpin	0	0	0	0	--	0	0	24
Prickly sculpin	0	0	0	0	--	0	0	0
Unidentified sculpin	0	0	0	0	--	0	0	0
Crayfish	1	3	0	0	--	3	0	1

Appendix Table B-5. Number of fish and crayfish collected in reaches of Tualatin River tributaries, winter 2000. L = lower reach, M = middle reach, and U = upper reach.

	Stream										
	Hedges			Fanno			S. Rock		Chicken		
Species	L	M	U	L	M	U	M	U	L	M	U
Western brook lamprey	0	0	0	--	0	0	0	--	0	0	0
Pacific lamprey	0	0	0	--	0	0	0	--	0	0	0
Unidentified lamprey	0	0	1	--	1	0	0	--	0	0	0
Cutthroat trout	1	0	0	--	2	11	5	--	0	0	3
Rainbow trout	0	0	2	--	0	3	0	--	1	0	0
Unidentified trout	0	0	0	--	0	0	0	--	0	0	0
Redside shiner	0	0	0	--	38	0	0	--	0	5	0
Speckled dace	0	0	0	--	0	0	0	--	0	0	0
Goldfish	0	0	0	--	0	0	0	--	0	0	0
Common carp	0	0	0	--	0	0	0	--	0	0	0
Fathead minnow	0	0	0	--	0	0	0	--	0	0	0
Largescale sucker	0	0	0	--	0	0	0	--	0	0	0
Brown bullhead	0	0	0	--	0	0	1	--	0	0	0
Yellow bullhead	0	0	0	--	0	0	0	--	0	0	0
Mosquitofish	0	0	0	--	0	0	0	--	0	0	0
Threespine stickleback	5	0	0	--	0	0	6	--	0	0	0
White crappie	0	0	0	--	0	0	0	--	0	0	0
Bluegill	0	0	0	--	0	0	2	--	0	0	0
Pumpkinseed	0	0	0	--	0	0	0	--	0	0	0
Warmouth	0	0	0	--	0	0	0	--	0	0	0
Largemouth bass	0	0	0	--	0	0	1	--	0	0	0
Unidentified *Lepomis*	0	0	0	--	0	0	0	--	0	0	0
Yellow perch	0	0	0	--	0	0	0	--	0	0	0
Reticulate sculpin	1	1	27	--	9	11	52	--	13	6	2
Torrent sculpin	0	0	0	--	0	0	0	--	0	0	0
Prickly sculpin	0	1	0	--	0	0	0	--	0	0	0
Unidentified sculpin	0	0	0	--	0	0	0	--	0	0	0
Crayfish	0	0	0	--	--	2	0	0	0	0	0

Appendix Table B-6. Number of fish and crayfish collected in reaches of Tualatin River tributaries, winter 2000. L = lower reach, M = middle reach, and U = upper reach.

	Stream							
	Butternut			N. Rock			Dairy	
Species	L	M	U	L	M	U	M	U
Western brook lamprey	0	0	0	--	--	0	--	0
Pacific lamprey	0	0	0	--	--	0	--	0
Unidentified lamprey	0	0	0	--	--	0	--	0
Cutthroat trout	0	0	0	--	--	5	--	2
Rainbow trout	0	0	0	--	--	5	--	6
Unidentified trout	0	0	0	--	--	0	--	0
Redside shiner	0	0	0	--	--	0	--	0
Speckled dace	0	40	196	--	--	0	--	0
Goldfish	0	0	0	--	--	0	--	0
Common carp	0	0	0	--	--	0	--	0
Fathead minnow	0	68	0	--	--	0	--	0
Largescale sucker	0	0	0	--	--	0	--	0
Brown bullhead	0	0	0	--	--	0	--	0
Yellow bullhead	0	0	0	--	--	0	--	0
Mosquitofish	0	5	0	--	--	0	--	0
Threespine stickleback	0	106	18	--	--	0	--	0
White crappie	0	1	0	--	--	0	--	0
Bluegill	0	0	0	--	--	0	--	0
Pumpkinseed	0	0	0	--	--	0	--	0
Warmouth	0	0	0	--	--	0	--	0
Largemouth bass	0	0	0	--	--	0	--	0
Unidentified *Lepomis*	0	0	0	--	--	0	--	0
Yellow perch	0	0	0	--	--	0	--	0
Reticulate sculpin	0	19	10	--	--	14	--	4
Torrent sculpin	0	0	0	--	--	0	--	1
Prickly sculpin	0	0	0	--	--	0	--	0
Unidentified sculpin	0	0	0	--	--	0	--	0
Crayfish	0	0	0	--	--	0	--	0

Appendix Table B-7. Number of fish and crayfish collected in reaches of Tualatin River tributaries, spring 2000. L = lower reach, M = middle reach, and U = upper reach.

	Stream										
	Hedges			Fanno			S. Rock		Chicken		
Species	L	M	U	L	M	U	M	U	L	M	U
Western brook lamprey	0	0	1	5	6	1	2	0	11	24	2
Pacific lamprey	0	0	0	1	0	0	0	0	0	0	0
Unidentified lamprey	0	0	0	0	0	0	0	0	0	0	0
Cutthroat trout	1	0	0	0	5	8	0	0	0	9	33
Rainbow trout	0	0	0	0	0	0	0	0	2	0	0
Unidentified trout	0	0	0	0	2	4	0	0	0	0	0
Redside shiner	0	0	0	1	49	1	0	0	2	21	0
Speckled dace	0	0	0	0	0	1	0	0	0	2	0
Goldfish	0	0	0	0	0	0	0	0	0	0	0
Common carp	0	0	0	0	0	0	0	0	0	0	0
Fathead minnow	0	0	0	0	0	0	0	0	0	0	0
Largescale sucker	0	0	0	0	0	0	0	0	35	1	0
Brown bullhead	0	0	0	0	0	0	5	0	0	0	0
Yellow bullhead	0	0	0	0	0	0	0	0	0	0	0
Mosquitofish	0	3	0	1	0	0	0	0	0	0	0
Threespine stickleback	68	16	0	0	0	0	25	10	0	0	0
White crappie	0	0	0	0	0	0	0	0	0	0	0
Bluegill	0	1	0	0	0	0	5	0	0	0	0
Pumpkinseed	0	0	0	0	0	0	0	0	0	0	0
Warmouth	0	0	0	0	0	0	1	0	0	0	0
Largemouth bass	3	1	0	0	0	0	1	0	0	0	0
Unidentified *Lepomis*	0	0	0	0	0	0	0	0	0	0	0
Yellow perch	3	0	0	0	0	0	0	0	0	0	0
Reticulate sculpin	280	0	107	76	225	86	276	0	307	107	90
Torrent sculpin	0	0	0	0	0	0	0	0	0	0	0
Prickly sculpin	0	0	0	0	0	0	2	0	0	0	0
Unidentified sculpin	0	0	0	0	0	0	0	0	0	0	0
Crayfish	0	0	1	2	2	2	2	0	4	4	8

Appendix Table B-8. Number of fish and crayfish collected in reaches of Tualatin River tributaries, spring 2000. L = lower reach, M = middle reach, and U = upper reach.

	Stream							
	Butternut			N. Rock			Dairy	
Species	L	M	U	L	M	U	M	U
Western brook lamprey	4	0	0	8	1	0	1	29
Pacific lamprey	0	0	0	0	0	0	0	0
Unidentified lamprey	0	0	0	0	0	0	0	0
Cutthroat trout	1	0	0	0	0	25	2	24
Rainbow trout	0	0	0	0	0	0	0	4
Unidentified trout	0	0	0	0	0	0	0	8
Redside shiner	0	0	0	0	4	0	0	0
Speckled dace	0	78	92	0	0	0	0	0
Goldfish	0	4	0	0	0	0	0	0
Common carp	1	0	0	0	0	0	0	0
Fathead minnow	0	0	0	0	0	0	0	0
Largescale sucker	1	0	0	0	3	0	0	0
Brown bullhead	0	0	0	0	0	0	0	0
Yellow bullhead	0	0	0	0	0	0	0	0
Mosquitofish	0	1	0	0	0	0	0	0
Threespine stickleback	0	67	14	0	4	0	0	0
White crappie	0	0	0	0	0	0	0	0
Bluegill	2	0	0	0	0	0	0	0
Pumpkinseed	0	0	0	1	0	0	0	0
Warmouth	0	0	0	0	0	0	0	0
Largemouth bass	1	0	0	0	0	0	0	0
Unidentified *Lepomis*	0	0	0	0	0	0	0	0
Yellow perch	0	0	0	0	0	0	0	0
Reticulate sculpin	87	193	0	179	147	62	61	85
Torrent sculpin	0	0	0	0	0	0	0	36
Prickly sculpin	0	0	0	0	0	0	0	0
Unidentified sculpin	0	0	0	0	0	0	0	0
Crayfish	4	3	0	6	1	2	2	0

Appendix Table B-9. Number of fish and crayfish collected in reaches of Tualatin River tributaries, summer 2000. L = lower reach, M = middle reach, and U = upper reach.

	Stream										
	Summer			Ash			Cedar		Dawson		
Species	L	M	U	L	M	U	M	U	L	M	U
Western brook lamprey	3	0	0	0	0	0	0	3	7	0	0
Pacific lamprey	0	0	0	0	0	0	0	3	0	0	0
Unidentified lamprey	0	0	0	0	0	0	0	0	0	0	0
Cutthroat trout	0	0	0	1	0	0	2	23	2	0	0
Rainbow trout	0	0	0	0	0	0	0	0	0	0	0
Unidentified trout	0	0	0	0	0	0	0	0	0	0	0
Redside shiner	47	6	0	10	15	16	39	23	1	1	0
Speckled dace	0	0	0	0	0	2	0	0	0	0	78
Goldfish	0	0	0	0	0	0	0	0	0	0	0
Common carp	0	0	0	0	0	1	0	0	0	0	0
Fathead minnow	0	0	25	0	1	0	0	0	0	0	0
Largescale sucker	0	0	0	1	0	0	1	0	0	0	0
Brown bullhead	1	10	0	0	0	0	0	0	0	0	0
Yellow bullhead	0	19	0	0	0	0	0	0	0	0	0
Mosquitofish	0	18	13	2	0	0	0	0	0	0	0
Threespine stickleback	0	0	0	0	0	0	1	4	0	0	86
White crappie	0	0	0	0	0	0	0	0	0	0	0
Bluegill	1	4	0	0	0	0	0	0	0	0	0
Pumpkinseed	0	8	0	0	0	0	0	0	0	0	0
Warmouth	0	0	0	0	0	0	0	0	0	0	0
Largemouth bass	0	0	0	0	0	0	0	0	1	0	0
Unidentified *Lepomis*	0	0	0	0	0	0	0	0	0	0	0
Yellow perch	0	0	0	0	0	0	0	0	0	0	0
Reticulate sculpin	274	2	0	67	89	40	53	204	139	68	72
Torrent sculpin	0	0	0	0	0	0	0	0	0	0	0
Prickly sculpin	0	0	0	0	0	0	0	0	0	0	0
Unidentified sculpin	0	0	0	0	0	0	0	0	0	0	0
Crayfish	25	1	4	4	4	2	0	28	11	13	8

Appendix Table B-10. Number of fish and crayfish collected in reaches of Tualatin River tributaries, summer 2000. L = lower reach, M = middle reach, and U = upper reach.

	Stream									
	Beaverton		Bronson		Cedar Mill		Johnson		Council	
Species	L	M	L	M	M	U	M	U	M	U
Western brook lamprey	0	1	3	12	1	6	0	0	0	0
Pacific lamprey	0	0	0	0	0	0	0	0	0	0
Unidentified lamprey	0	0	0	0	0	1	0	0	0	0
Cutthroat trout	0	0	0	2	0	0	0	0	0	0
Rainbow trout	0	0	0	1	0	0	0	0	0	0
Unidentified trout	0	0	0	0	0	0	0	0	0	0
Redside shiner	1	3	0	0	8	5	2	0	2	0
Speckled dace	0	0	0	0	0	0	1	0	1	9
Goldfish	0	0	0	0	0	0	0	0	0	0
Common carp	0	0	0	0	0	0	0	0	0	0
Fathead minnow	0	0	0	0	0	0	0	0	0	0
Largescale sucker	0	0	0	0	0	0	0	0	0	0
Brown bullhead	0	0	0	0	0	0	0	0	0	0
Yellow bullhead	0	1	0	0	0	0	0	0	0	4
Mosquitofish	0	1	0	0	2	0	3	0	0	3
Threespine stickleback	0	0	24	0	2	0	4	0	0	2
White crappie	0	0	0	0	0	0	0	0	0	0
Bluegill	0	0	1	0	0	0	0	0	0	0
Pumpkinseed	0	0	0	0	0	0	0	0	0	0
Warmouth	0	0	0	0	0	0	0	0	0	0
Largemouth bass	0	0	15	0	0	0	0	0	6	0
Unidentified *Lepomis*	0	0	0	0	0	0	0	0	0	0
Yellow perch	0	0	0	0	0	0	0	0	0	0
Reticulate sculpin	96	123	108	140	176	278	47	0	31	4
Torrent sculpin	0	0	0	0	0	0	0	0	0	0
Prickly sculpin	0	0	0	0	0	0	0	0	0	0
Unidentified sculpin	0	0	0	0	0	0	0	0	0	0
Crayfish	1	11	3	18	4	19	1	0	1	0

Appendix Table B-11. Number of fish and crayfish collected in reaches of Tualatin River tributaries, fall 2000. L = lower reach, M = middle reach, and U = upper reach.

	Stream										
	Summer			Ash			Cedar		Dawson		
Species	L	M	U	L	M	U	M	U	L	M	U
Western brook lamprey	33	0	0	0	0	0	0	0	0	0	0
Pacific lamprey	0	0	0	0	0	0	0	0	0	0	0
Unidentified lamprey	0	0	0	0	0	0	3	0	0	0	0
Cutthroat trout	0	0	0	0	0	0	8	2	0	0	0
Rainbow trout	0	0	0	0	0	0	2	0	0	0	0
Unidentified trout	0	0	0	0	0	0	0	0	0	0	0
Redside shiner	1	1	90	37	78	84	4	53	0	11	0
Speckled dace	0	0	0	0	0	1	0	0	1	13	0
Goldfish	0	0	1	0	0	0	0	0	0	0	0
Common carp	0	0	0	0	0	0	0	0	0	0	0
Fathead minnow	0	0	0	0	0	0	0	0	0	0	0
Largescale sucker	0	0	0	4	0	0	3	9	0	0	0
Brown bullhead	3	3	0	0	0	0	0	0	0	0	0
Yellow bullhead	0	23	0	0	0	0	0	0	0	0	0
Mosquitofish	0	9	508	0	0	0	0	0	0	0	0
Threespine stickleback	0	0	0	4	0	0	0	5	0	1	39
White crappie	0	0	0	0	0	0	0	0	0	0	0
Bluegill	0	151	5	0	0	0	0	0	0	0	0
Pumpkinseed	19	145	5	0	0	0	0	0	0	0	0
Warmouth	0	0	0	0	0	0	0	0	0	0	0
Largemouth bass	0	1	1	0	0	0	0	0	0	0	0
Unidentified *Lepomis*	0	0	0	0	0	0	0	0	0	0	0
Yellow perch	0	0	0	0	0	0	0	0	0	0	0
Reticulate sculpin	286	3	0	12	131	100	68	16	13	13	5
Torrent sculpin	0	0	0	0	0	0	0	0	0	0	0
Prickly sculpin	0	0	0	0	0	0	0	0	0	0	0
Unidentified sculpin	0	0	0	0	0	0	0	0	0	0	0
Crayfish	15	8	0	0	2	1	12	2	12	2	1

Appendix Table B-12. Number of fish and crayfish collected in reaches of Tualatin River tributaries, fall 2000. L = lower reach, M = middle reach, and U = upper reach.

	Stream									
	Beaverton		Bronson		Cedar Mill		Johnson		Council	
Species	L	M	L	M	M	U	M	U	M	U
Western brook lamprey	1	1	3	0	0	3	0	0	0	0
Pacific lamprey	0	0	0	0	0	0	0	0	0	0
Unidentified lamprey	0	0	0	3	0	0	0	0	0	0
Cutthroat trout	0	0	0	0	0	0	0	0	0	0
Rainbow trout	0	0	0	0	0	0	0	0	0	0
Unidentified trout	0	0	0	0	0	0	0	0	0	0
Redside shiner	0	14	0	0	0	0	1	0	3	0
Speckled dace	0	0	0	0	2	0	1	0	3	7
Goldfish	0	0	0	0	2	0	0	0	0	0
Common carp	0	0	0	0	0	0	0	0	0	0
Fathead minnow	0	0	0	0	182	4	0	0	0	0
Largescale sucker	0	2	0	0	1	0	0	0	0	0
Brown bullhead	0	0	0	0	0	0	0	0	0	0
Yellow bullhead	0	1	0	0	0	0	0	0	0	4
Mosquitofish	5	3	0	0	6	0	3	0	0	2
Threespine stickleback	1	4	7	0	7	0	2	0	4	8
White crappie	0	0	0	0	0	0	0	0	0	0
Bluegill	0	0	0	0	3	0	0	0	4	0
Pumpkinseed	0	0	0	0	0	0	4	0	0	0
Warmouth	0	0	0	0	0	0	0	0	0	0
Largemouth bass	0	1	4	0	0	0	0	0	8	0
Unidentified *Lepomis*	0	0	0	0	0	0	0	0	0	0
Yellow perch	0	0	0	0	0	0	0	0	0	0
Reticulate sculpin	34	27	25	72	16	68	59	0	20	10
Torrent sculpin	0	0	0	0	0	0	0	0	0	0
Prickly sculpin	0	0	0	0	0	0	0	0	0	0
Unidentified sculpin	0	0	0	0	0	0	0	0	0	0
Crayfish	3	8	2	7	0	4	0	0	0	0

Appendix Table B-13. Number of fish and crayfish collected in reaches of Tualatin River tributaries, winter 2000. L = lower reach, M = middle reach, and U = upper reach.

	Stream										
	Summer			Ash			Cedar		Dawson		
Species	L	M	U	L	M	U	M	U	L	M	U
Western brook lamprey	0	0	0	0	0	0	0	4	1	0	0
Pacific lamprey	0	0	0	0	0	0	0	0	0	0	0
Unidentified lamprey	0	0	0	0	0	0	0	1	0	0	0
Cutthroat trout	0	0	0	0	0	0	0	0	0	0	1
Rainbow trout	0	0	0	0	0	0	0	0	0	0	0
Unidentified trout	0	0	0	0	0	0	0	0	0	0	0
Redside shiner	3	0	0	0	22	12	9	3	0	12	0
Speckled dace	0	0	0	0	0	0	0	0	0	0	0
Goldfish	0	0	0	0	0	0	0	0	0	0	0
Common carp	0	0	0	0	0	0	0	0	0	0	0
Fathead minnow	9	873	25	0	0	0	0	0	0	0	0
Largescale sucker	3	10	0	7	1	0	0	3	0	0	1
Brown bullhead	0	1	0	0	0	0	0	0	0	0	0
Yellow bullhead	11	0	0	0	0	0	0	0	0	0	0
Mosquitofish	0	13	28	0	0	0	0	0	0	0	0
Threespine stickleback	0	0	0	0	0	0	2	0	5	5	0
White crappie	0	0	0	0	0	0	0	0	0	0	0
Bluegill	2	38	0	0	0	0	0	0	0	0	0
Pumpkinseed	0	61	1	0	0	0	0	0	0	0	0
Warmouth	0	0	0	0	0	0	0	0	0	0	0
Largemouth bass	0	5	1	0	0	0	0	0	0	0	0
Unidentified *Lepomis*	0	81	2	0	0	0	0	0	0	0	0
Yellow perch	0	0	0	0	0	0	0	0	0	0	0
Reticulate sculpin	34	3	0	15	60	45	14	140	0	5	6
Torrent sculpin	0	0	0	0	0	0	0	0	0	0	0
Prickly sculpin	0	0	0	0	0	0	0	0	0	0	0
Unidentified sculpin	0	0	0	0	0	0	0	0	0	0	0
Crayfish	0	0	0	0	0	0	0	3	0	0	0

Appendix Table B-14. Number of fish and crayfish collected in reaches of Tualatin River tributaries, winter 2000. L = lower reach, M = middle reach, and U = upper reach.

	Stream									
	Beaverton		Bronson		Cedar Mill		Johnson		Council	
Species	L	M	L	M	M	U	M	U	M	U
Western brook lamprey	0	2	1	1	0	3	0	0	0	0
Pacific lamprey	0	0	0	0	0	0	0	0	0	0
Unidentified lamprey	0	0	0	0	0	0	0	0	0	0
Cutthroat trout	0	10	0	0	0	0	0	0	9	0
Rainbow trout	0	0	0	0	0	0	0	0	0	0
Unidentified trout	0	0	0	0	0	0	0	0	0	0
Redside shiner	0	5	0	0	0	0	7	0	2	4
Speckled dace	0	0	0	0	0	0	0	8	1	0
Goldfish	0	0	0	0	0	1	0	0	0	0
Common carp	0	0	0	0	0	0	0	0	0	0
Fathead minnow	0	1	0	0	95	0	0	0	0	3
Largescale sucker	0	1	0	0	0	0	0	0	0	0
Brown bullhead	0	0	0	0	0	0	0	0	0	0
Yellow bullhead	0	0	0	0	0	0	0	0	0	0
Mosquitofish	0	0	0	0	7	0	0	2	0	0
Threespine stickleback	2	1	22	0	7	0	6	18	1	7
White crappie	1	0	0	0	0	0	0	0	0	0
Bluegill	0	0	0	0	2	0	0	0	0	1
Pumpkinseed	0	0	0	0	0	0	0	0	0	0
Warmouth	0	0	0	0	0	0	0	0	0	0
Largemouth bass	0	2	0	0	0	0	0	0	3	0
Unidentified *Lepomis*	0	0	0	0	0	0	0	0	0	0
Yellow perch	0	0	0	0	0	0	0	0	0	0
Reticulate sculpin	35	17	31	11	20	135	20	3	3	0
Torrent sculpin	0	0	0	0	0	0	0	0	0	0
Prickly sculpin	0	0	0	0	0	0	0	0	0	0
Unidentified sculpin	0	0	0	0	0	0	0	0	0	0
Crayfish	0	0	0	0	0	0	0	0	0	0

Appendix Table B-15. Number of fish and crayfish collected in reaches of Tualatin River tributaries, spring 2001. L = lower reach, M = middle reach, and U = upper reach.

	Stream										
	Summer			Ash			Cedar		Dawson		
Species	L	M	U	L	M	U	M	U	L	M	U
Western brook lamprey	3	0	0	0	0	0	0	5	0	1	1
Pacific lamprey	0	0	0	0	0	0	0	0	0	0	0
Unidentified lamprey	0	0	0	0	0	0	0	0	0	0	0
Cutthroat trout	0	0	0	0	0	0	0	0	0	0	0
Rainbow trout	0	0	0	0	0	0	0	0	0	0	0
Unidentified trout	0	0	0	0	0	0	0	0	0	0	0
Redside shiner	39	0	0	9	112	24	20	4	0	52	1
Speckled dace	0	0	0	0	0	4	0	0	2	1	5
Goldfish	0	0	0	0	0	0	0	0	0	0	0
Common carp	0	0	0	0	0	0	0	0	0	0	0
Fathead minnow	0	9	26	0	0	0	0	1	0	0	0
Largescale sucker	0	0	0	4	0	0	0	0	0	0	0
Brown bullhead	1	0	0	0	0	0	0	0	0	0	0
Yellow bullhead	1	53	0	0	0	0	0	0	0	0	0
Mosquitofish	0	0	6	0	0	0	0	0	0	2	1
Threespine stickleback	0	0	0	1	0	0	6	1	0	24	6
White crappie	0	0	0	0	0	0	0	0	0	0	0
Bluegill	10	22	7	0	0	0	0	0	0	0	0
Pumpkinseed	0	0	0	0	0	0	0	0	0	0	0
Warmouth	0	0	0	0	0	0	0	0	0	0	0
Largemouth bass	0	0	0	0	0	0	0	0	0	0	0
Unidentified *Lepomis*	0	0	0	0	0	0	0	0	0	0	0
Yellow perch	0	0	0	0	0	0	0	0	0	0	0
Reticulate sculpin	211	36	0	79	247	95	38	61	33	45	1
Torrent sculpin	0	0	0	0	0	0	0	0	0	0	0
Prickly sculpin	0	0	0	0	0	0	0	0	0	0	0
Unidentified sculpin	0	0	0	0	0	0	0	0	0	0	0
Crayfish	13	2	0	3	6	1	1	4	0	5	0

Appendix Table B-16. Number of fish and crayfish collected in reaches of Tualatin River tributaries, spring 2001. L = lower reach, M = middle reach, and U = upper reach.

	Stream									
	Beaverton		Bronson		Cedar Mill		Johnson		Council	
Species	L	M	L	M	M	U	M	U	M	U
Western brook lamprey	0	23	18	13	3	10	0	0	0	0
Pacific lamprey	0	0	0	0	1	0	0	0	0	0
Unidentified lamprey	0	0	0	0	0	0	0	0	0	0
Cutthroat trout	0	0	0	3	0	0	0	0	0	0
Rainbow trout	0	0	0	0	0	0	0	0	0	0
Unidentified trout	0	0	0	0	0	0	0	0	0	0
Redside shiner	0	19	0	0	3	0	1	0	0	0
Speckled dace	0	0	1	0	1	0	0	0	0	5
Goldfish	0	0	0	0	0	0	0	0	0	0
Common carp	0	0	0	0	0	0	0	0	0	0
Fathead minnow	0	0	0	0	0	15	0	0	0	0
Largescale sucker	1	0	0	0	0	0	0	0	0	0
Brown bullhead	0	0	0	0	2	0	0	0	0	7
Yellow bullhead	0	1	0	0	0	0	0	0	0	1
Mosquitofish	1	0	0	0	0	0	0	0	0	81
Threespine stickleback	0	7	7	0	17	0	0	0	8	3
White crappie	0	0	0	0	0	0	0	0	0	0
Bluegill	0	1	0	0	1	0	2	0	0	0
Pumpkinseed	0	0	0	0	0	0	0	0	0	0
Warmouth	0	1	0	0	0	0	0	0	0	0
Largemouth bass	0	0	0	0	0	0	0	0	0	0
Unidentified *Lepomis*	0	0	0	0	0	0	0	0	0	0
Yellow perch	0	0	0	0	0	0	0	0	0	0
Reticulate sculpin	54	129	85	50	269	122	50	0	36	2
Torrent sculpin	0	0	0	0	0	0	0	0	0	0
Prickly sculpin	0	0	0	0	0	0	0	0	0	0
Unidentified sculpin	0	0	0	0	0	0	0	0	0	0
Crayfish	1	8	2	1	2	3	1	0	0	0

APPENDIX C

Habitat Survey Data

Appendix Table C-1. Habitat summary for reaches of Tualatin River tributaries, summer 1999. L= lower reach, M = middle reach, and U = upper reach. Woody debris is a rating of wood complexity as it relates to fish habitat and ranges from 1 to 5 with 5 being the most complex (Moore et al. 1993).

	Stream										
	Hedges			Fanno			S. Rock		Chicken		
	L	M	U	L	M	U	M	U	L	M	U
Meters sampled	574	215	492	2050	1668	559	311	650	605	514	762
Habitat type (%)											
Glide	76.2	100.0	73.6	53.9	87.9	63.6	99.7	24.1	54.7	87.4	29.1
Pool	13.2	0.0	2.6	30.0	6.5	13.4	0.0	34.1	25.3	9.9	0.0
Riffle	8.1	0.0	16.0	15.4	4.1	20.4	0.0	0.0	16.5	0.0	57.3
Rapid	0.0	0.0	1.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Other	2.5	0.0	6.8	0.7	1.5	2.5	0.3	41.8	3.5	2.6	13.6
Substrate (%)											
Soil	70.4	99.8	78.3	48.2	83.2	45.3	95.6	93.1	90.9	85.5	15.4
Rock	26.9	0.2	16.0	50.6	11.8	54.1	4.3	1.1	9.1	6.1	58.1
Boulder	1.4	0.0	4.0	1.2	4.8	0.7	0.1	4.4	0.0	3.0	14.2
Bedrock	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	5.3	12.0
Bank type (%)											
Eroding	2.4	0.0	33.7	20.9	65.1	23.1	76.3	60.0	77.8	32.9	1.2
Undercut	3.6	0.0	11.9	6.8	8.7	7.9	35.4	2.4	17.8	7.3	1.7
Shade (%)	51.3	6.8	62.6	62.7	68.1	63.4	27.5	16.5	60.8	44.8	74.2
Gradient (%)	1.1	0.7	0.7	0.4	0.3	1.0	0.2	0.1	0.5	0.3	3.0
Woody debris	1.0	1.0	1.7	1.5	1.5	1.2	1.0	1.0	1.7	1.8	1.5

Appendix Table C-2. Habitat summary for reaches of Tualatin River tributaries, summer 1999. L = lower reach, M = middle reach, and U = upper reach. Woody debris is a rating of wood complexity as it relates to fish habitat and ranges from 1 to 5 with 5 being the most complex (Moore et al. 1993).

	Stream							
	Butternut			N. Rock			Dairy	
	L	M	U	L	M	U	M	U
Meters sampled	358	651	341	911	215	402	1005	449
Habitat type (%)								
Glide	72.5	66.1	67.1	80.0	69.9	27.4	91.4	15.9
Pool	7.4	1.9	0.0	4.9	29.4	3.7	5.2	21.6
Riffle	9.2	1.1	5.1	13.3	0.1	66.0	2.6	35.7
Rapid	0.0	0.0	0.0	0.0	0.0	0.0	0.0	23.5
Other	11.0	31.0	27.9	1.8	0.6	2.9	0.9	3.3
Substrate (%)								
Soil	92.8	67.3	71.5	80.3	93.7	5.5	98	2.7
Rock	3.2	32.3	22.9	17.9	5.4	27.8	1.2	54.1
Boulder	2.8	0.3	5.6	1.0	0.9	5.9	0.0	14.4
Bedrock	1.2	0.0	0.0	0.0	0.0	60.9	0.0	28.9
Bank type (%)								
Eroding	59.0	4.5	6.1	73.3	32.8	21.9	82.5	5.6
Undercut	21.2	0.0	2.7	3.5	10.3	3.0	0.0	7.1
Shade (%)	66.1	65.7	37.8	68.9	39.6	78.7	49.9	79.0
Gradient (%)	1.2	0.1	0.2	0.3	0.2	2.2	0.1	2.2
Woody debris	1.5	1.0	1.0	1.8	1.3	1.0	1.0	1.5

Appendix Table C-3. Habitat summary for reaches of Tualatin River tributaries, summer 2000. L = lower reach, M = middle reach, and U = upper reach. Woody debris is a rating of wood complexity as it relates to fish habitat and ranges from 1 to 5 with 5 being the most complex (Moore et al. 1993).

	Stream										
	Summer			Ash			Cedar		Dawson		
	L	M	U	L	M	U	M	U	L	M	U
Meters sampled	1521	658	283	878	576	759	605	405	623	845	1083
Habitat type (%)											
Glide	60.5	6.5	99.1	95.3	62.1	0	67.5	81.0	12.8	70.6	88.8
Pool	30.2	92.2	0.0	1.8	20.2	0	3.1	10.6	86.3	26.0	10.5
Riffle	8.8	0.7	0.6	3.0	9.2	0	1.0	8.4	0.0	1.3	0.1
Rapid	0.0	0.0	0	0.0	0.0	0	0.0	0.0	0.0	0.0	0.0
Other	0.5	0.6	0	0.0	8.5	0	28.4	0.0	0.9	2.1	0.6
Substrate (%)											
Soil	85.5	93.1	91.5	92.5	64.4	75.1	93.1	87.2	95.3	96.4	100.0
Rock	12.9	6.1	7.3	5.8	31.5	24.1	3.9	12.0	3.6	3.6	0.0
Boulder	1.5	0.8	1.2	1.7	4.1	0.8	3.0	0.8	1.1	0.0	0.0
Bedrock	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Bank type (%)											
Eroding	28.0	6.0	2.9	0.4	13.4	11.9	3.3	18.6	6.3	9.2	2.6
Undercut	16.8	14.9	1.6	0.8	10.7	10.3	1.5	6.6	22.9	0.7	0.0
Shade (%)	72.1	9.3	25.3	44.4	56.4	82.5	46.1	69.6	48.7	63.2	26.2
Gradient (%)	0.4	0.6	0.6	0.1	1.3	1.1	0.0	1.0	0.6	1.0	0.9
Woody debris	1.5	1.4	1.0	1.2	1.4	1.2	1.5	2.4	1.6	1.0	1.8

Appendix Table C-4. Habitat summary for reaches of Tualatin River tributaries, summer 2000. L = lower reach, M = middle reach, and U = upper reach. Woody debris is a rating of wood complexity as it relates to fish habitat and ranges from 1 to 5 with 5 being the most complex (Moore et al. 1993).

	Stream									
	Beaverton		Bronson		Cedar Mill		Johnson		Council	
	L	M	L	M	M	U	M	U	M	U
Meters sampled	1500	2264	371	498	926	798	817	443	1046	1000
Habitat type (%)										
Glide	81.1	97.1	86.7	95.0	39.9	18.2	50.1	70.0	13.0	88.6
Pool	17.0	0.0	1.3	4.0	30.5	21.3	0.0	14.6	87.0	0.0
Riffle	1.8	2.9	0.0	0.0	0.0	58.2	0.0	13.7	0.0	0.0
Rapid	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Other	0.2	0.0	12.0	0.9	29.6	2.3	49.9	1.7	0.0	11.4
Substrate (%)										
Soil	91.5	80.0	70.0	58.3	87.6	25.9	99.9	93.0	100.0	97.4
Rock	8.4	17.2	9.4	39.7	12.1	47.4	0.1	6.7	0.0	2.6
Boulder	0.1	1.8	0.0	1.9	0.3	9.1	0.0	0.3	0.0	0.0
Bedrock	0.0	1.0	20.6	0.1	0.0	17.6	0.0	0.0	0.0	0.0
Bank type (%)										
Eroding	59.2	5.7	3.8	11.0	4.9	3.3	0.0	5.2	0.6	38.3
Undercut	5.2	10.3	5.6	6.9	9.7	3.6	0.0	6.7	2.4	11.0
Shade (%)	78.1	77.7	57.4	79.1	29.5	86.6	25.1	79.4	35.9	13.0
Gradient (%)	0.3	0.5	0.5	1.1	0.9	2.4	0.0	2.0	0.3	0.0
Woody debris	1.5	2.6	1.1	1.0	1.0	1.8	1.0	1.7	1.4	1.0

APPENDIX D

Water Quality Data

Appendix Table D-1. Water quality measurements in reaches of Tualatin River tributaries, summer 1999. L = lower reach, M = middle reach, and U = upper reach.

	Stream										
	Hedges			Fanno			S. Rock		Chicken		
	L	M	U	L	M	U	M	U	L	M	U
Turbidity (NTU)	12.9	65.9	31.6	4.7	13.0	4.9	4.2	37.4	12.5	17.2	10.2
Oxygen saturation (%)	54.2	30.4	103.8	73.1	85.3	101.7	60.0	47.1	80.5	85.2	121.0
Dissolved oxygen (mg/L)	5.8	3.9	10.2	6.7	8.1	10.0	6.3	4.4	9.0	10.1	13.3
Temperature (°C)	17.0	19.0	16.5	16.5	17.8	16.6	13.2	16.6	16.0	12.0	12.0
Mean velocity (m/s)	2.0	0.0	1.7	2.5	2.4	2.3	0.8	0.0	0.6	0.8	2.7
Maximum velocity (m/s)	3.5	0.0	2.2	8.3	3.6	5.1	3.0	0.0	1.7	1.6	4.9
Conductivity (µS)	173.7	221.0	206.0	239.0	224.0	171.7	342.0	265.0	173.2	88.5	67.9
Total dissolved solids (mg/L)	82.9	105.6	98.6	114.6	107.4	82.0	164.8	127.2	82.7	41.9	32.0
Salinity (ppt)	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.0	0.0
pH	--	--	--	--	--	--	--	--	--	--	--

Appendix Table D-2. Water quality measurements in reaches of Tualatin River tributaries, summer 1999. L = lower reach, M = middle reach, and U = upper reach.

	Stream							
	Butternut			N. Rock			Dairy	
	L	M	U	L	M	U	M	U
Turbidity (NTU)	7.8	3.8	8.0	--	3.8	2.2	6.6	2.5
Oxygen saturation (%)	86.3	15.3	100.7	--	43.8	120.0	105.7	116.2
Dissolved oxygen (mg/L)	8.9	1.5	10.4	8.4	4.3	13.5	10.9	12.1
Temperature (°C)	14.2	16.5	13.7	17.6	16.2	12.0	14.5	13.4
Mean velocity (m/s)	0.0	0.0	0.0	--	0.0	0.0	2.7	2.7
Maximum velocity (m/s)	0.0	0.0	0.0	--	0.0	0.0	4.3	5.1
Conductivity (µS)	288.0	181.9	156.9	--	266.0	107.7	70.5	64.5
Total dissolved solids (mg/L)	138.2	86.9	74.8	--	127.9	51.1	33.3	30.4
Salinity (ppt)	0.1	0.1	0.1	--	0.1	0.1	0.0	0.0
pH	--	--	--	7.4	--	--	--	--

Appendix Table D-3. Water quality measurements in reaches of Tualatin River tributaries, fall 1999. L = lower reach, M = middle reach, and U = upper reach.

	Stream										
	Hedges			Fanno			S. Rock		Chicken		
	L	M	U	L	M	U	M	U	L	M	U
Turbidity (NTU)	4.3	6.3	6.0	7.6	26.1	13.3	7.0	11.5	20.3	14.1	7.9
Oxygen saturation (%)	32.9	64.5	97.7	90.1	81.5	94.7	93.5	98.4	96.6	--	113.5
Dissolved oxygen (mg/L)	3.8	6.6	10.6	10.1	9.4	10.4	10.0	10.3	10.7	11.5	13.0
Temperature (°C)	10.3	13.7	11.5	10.5	11.2	11.2	11.2	13.8	11.1	9.6	9.4
Mean velocity (m/s)	1.7	0.0	1.2	3.2	2.4	2.5	2.6	0.0	1.3	0.9	3.0
Maximum velocity (m/s)	3.4	0.0	1.8	11.1	3.8	2.7	4.3	0.0	2.1	1.3	4.3
Conductivity (μS)	175.9	198.1	172.1	270.0	125.4	115.4	298.0	268.0	112.0	89.0	68.1
Total dissolved solids (mg/L)	84.0	94.7	82.2	129.8	50.0	54.8	143.1	128.7	53.2	42.1	32.1
Salinity (ppt)	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1
pH	--	--	--	--	--	--	--	--	7.2	--	--

Appendix Table D-4. Water quality measurements in reaches of Tualatin River tributaries, fall 1999. L = lower reach, M = middle reach, and U = upper reach.

	Stream							
	Butternut			N. Rock			Dairy	
	L	M	U	L	M	U	M	U
Turbidity (NTU)	6.7	23.2	14.0	15.2	17.6	2.7	3.1	0.7
Oxygen saturation (%)	96.9	--	--	81.0	27.6	80.2	98.4	75.2
Dissolved oxygen (mg/L)	11.3	4.5	7.7	8.6	3.1	9.2	8.9	9.1
Temperature (°C)	8.5	9.5	8.3	12.4	10.2	6.8	8.9	7.3
Mean velocity (m/s)	5.1	0.0	0.0	2.9	0.0	0.0	2.8	5.3
Maximum velocity (m/s)	11.1	0.0	0.0	4.6	0.0	0.0	2.8	5.3
Conductivity (µS)	299.0	191.1	149.7	216.0	290.0	111.8	72.7	65.7
Total dissolved solids (mg/L)	143.9	91.4	71.4	103.5	139.1	53.1	34.3	31.0
Salinity (ppt)	0.1	0.1	0.1	0.1	0.1	0.1	0.0	0.0
pH	--	--	--	7.3	--	--	--	--

Appendix Table D-5. Water quality measurements in reaches of Tualatin River tributaries, winter 2000. L = lower reach, M = middle reach, and U = upper reach.

	Stream										
	Hedges			Fanno			S. Rock		Chicken		
	L	M	U	L	M	U	M	U	L	M	U
Turbidity (NTU)	25.6	51.9	14.3	--	25.9	25.6	17.6	4.2	23.6	11.4	10.8
Oxygen saturation (%)	73.5	81.9	92.5	--	85.2	93.3	79.8	49.7	89.4	92.2	89.2
Dissolved oxygen (mg/L)	9.3	10.6	10.8	--	10.5	11.4	9.6	6.5	11.1	11.4	11.7
Temperature (°C)	4.9	4.7	8.5	--	6.5	6.7	7.5	4.2	5.9	6.4	7.9
Mean velocity (m/s)	2.0	2.0	1.4	--	1.8	3.0	2.5	0.5	5.5	2.8	3.5
Maximum velocity (m/s)	3.9	2.8	2.7	--	2.9	4.4	3.7	1.5	8.4	3.8	6.4
Conductivity (µS)	99.1	77.4	101.7	--	105.4	84.6	111.6	76.4	66.4	52.5	50.4
Total dissolved solids (mg/L)	47.0	36.6	48.2	--	50.0	40.0	53.0	36.1	31.3	24.6	23.6
Salinity (ppt)	0.1	0.0	0.1	--	0.1	0.0	0.1	0.0	0.0	0.0	0.0
pH	7.1	6.9	7.1	--	7.3	7.4	6.7	6.4	7.3	7.2	7.2

Appendix Table D-6. Water quality measurements in reaches of Tualatin River tributaries, winter 2000. L = lower reach, M = middle reach, and U = upper reach.

	Stream							
	Butternut			N. Rock			Dairy	
	L	M	U	L	M	U	M	U
Turbidity (NTU)	13.9	25.4	14.8	--	--	14.2	--	4.9
Oxygen saturation (%)	82.0	96.2	100.5	--	--	95.8	--	96.3
Dissolved oxygen (mg/L)	11.4	11.5	11.4	--	--	12.3	--	12.4
Temperature (°C)	6.9	7.6	10.0	--	--	5.0	--	5.8
Mean velocity (m/s)	0.5	0.3	1.3	--	--	2.2	--	7.6
Maximum velocity (m/s)	1.0	0.6	2.0	--	--	3.1	--	10.6
Conductivity (μS)	135.0	163.3	142.0	--	--	20.1	--	44.0
Total dissolved solids (mg/L)	64.3	77.9	67.6	--	--	9.1	--	20.5
Salinity (ppt)	0.1	0.1	0.1	--	--	0.0	--	0.0
pH	7.4	7.2	7.3	--	--	7.3	--	7.1

Appendix Table D-7. Water quality measurements in reaches of Tualatin River tributaries, spring 2000. L = lower reach, M = middle reach, and U = upper reach.

	Stream										
	Hedges			Fanno			S. Rock		Chicken		
	L	M	U	L	M	U	M	U	L	M	U
Turbidity (NTU)	18.7	8.5	4.3	9.5	12.5	5.8	6.2	6.7	7.3	8.1	10.8
Oxygen saturation (%)	73.8	87.4	96.1	94.1	95.2	102.2	88.9	79.6	99.7	100.0	107.7
Dissolved oxygen (mg/L)	8.1	10.1	10.9	9.4	10.7	10.5	10.0	8.8	10.6	11.3	11.6
Temperature (°C)	11.3	9.1	9.7	14.7	10.1	10.0	10.2	11.1	12.3	9.9	12.3
Mean velocity (m/s)	2.3	0.0	0.6	0.3	0.7	0.6	1.1	0.6	1.3	2.5	1.6
Maximum velocity (m/s)	3.5	0.0	1.0	2.4	1.2	1.2	2.0	0.9	2.5	4.6	3.1
Conductivity (μS)	165.7	176.1	169.0	201.0	127.6	196.5	159.2	102.3	98.6	61.3	52.6
Total dissolved solids (mg/L)	79.0	84.1	80.7	96.2	60.7	94.0	76.0	48.6	46.7	28.8	24.7
Salinity (ppt)	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.0	0.0	0.0	0.0
pH	6.9	5.0	7.4	7.8	7.2	7.7	6.9	6.7	7.5	7.3	7.6

Appendix Table D-8. Water quality measurements in reaches of Tualatin River tributaries, spring 2000. L = lower reach, M = middle reach, and U = upper reach.

	Stream							
	Butternut			N. Rock			Dairy	
	L	M	U	L	M	U	M	U
Turbidity (NTU)	3.7	11.1	5.3	6.5	8.9	7.0	5.4	2.3
Oxygen saturation (%)	89.4	115.6	108.5	80.8	88.7	99.4	96.7	104.2
Dissolved oxygen (mg/L)	9.0	12.0	11.6	7.5	9.8	11.3	9.8	13.2
Temperature (°C)	14.7	13.6	12.1	18.6	11.5	10.9	15.0	5.5
Mean velocity (m/s)	0.0	0.5	0.0	0.9	0.7	1.6	2.5	3.7
Maximum velocity (m/s)	0.0	0.7	0.0	2.5	1.2	2.0	3.9	6.3
Conductivity (μS)	260.0	212.0	164.0	287.0	168.5	47.0	62.8	52.6
Total dissolved solids (mg/L)	125.0	101.4	78.3	138.0	80.5	22.0	29.6	24.7
Salinity (ppt)	0.1	0.1	0.1	0.1	0.1	0.0	0.0	0.0
pH	7.5	7.6	7.6	7.4	7.6	7.2	7.3	7.8

Appendix Table D-9. Water quality measurements in reaches of Tualatin River tributaries, summer 2000. L = lower reach, M = middle reach, and U = upper reach.

	Stream										
	Summer			Ash			Cedar		Dawson		
	L	M	U	L	M	U	M	U	L	M	U
Turbidity (NTU)	7.6	7.8	7.2	13.8	15.1	17.9	7.0	13.2	6.5	10.5	6.8
Oxygen saturation (%)	96.0	103.3	86.3	62.8	94.2	87.7	25.0	83.0	65.9	57.2	103.4
Dissolved oxygen (mg/L)	8.2	8.4	7.7	5.8	8.7	8.5	2.46	7.9	6.4	5.35	8.94
Temperature (°C)	22.4	28.0	21.0	19.2	19.5	16.9	16.6	17.1	16.6	18.0	21.9
Mean velocity (m/s)	1.3	0.0	0.0	0.0	0.9	0.4	0.0	0.8	0.0	0.0	0.0
Maximum velocity (m/s)	1.6	0.0	0.0	0.0	1.1	0.7	0.0	1.4	0.0	0.0	0.0
Conductivity (μS)	234.0	242.0	174.6	175.1	131.3	164.6	217.0	118.5	347.0	362.0	370.0
Total dissolved solids (mg/L)	112.3	116.1	83.4	83.6	62.5	78.6	104.0	56.3	166.9	174.3	178.3
Salinity (ppt)	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1
pH	7.5	7.4	7.4	7.3	7.3	7.3	6.8	7.0	7.2	7.5	7.8

Appendix Table D-10. Water quality measurements in reaches of Tualatin River tributaries, summer 2000. L = lower reach, M = middle reach, and U = upper reach.

	Stream									
	Beaverton		Bronson		Cedar Mill		Johnson		Council	
	L	M	L	M	M	U	M	U	M	U
Turbidity (NTU)	5.3	6.7	5.5	23.6	12.0	9.1	3.6	10.5	4.6	22.2
Oxygen saturation (%)	76.0	56.8	94.4	10.9	64.2	112.9	28.4	99.7	22.9	98.5
Dissolved oxygen (mg/L)	7.0	5.0	8.6	12.0	5.9	11.4	2.6	19.2	2.2	8.5
Temperature (°C)	19.8	21.3	20.2	12.2	19.5	13.9	19.3	19.1	17.4	23.3
Mean velocity (m/s)	2.0	1.3	0.0	0.0	0.0	1.8	0.0	0.0	0.8	0.0
Maximum velocity (m/s)	4.1	2.0	0.0	0.0	0.0	2.3	0.0	0.0	1.1	0.0
Conductivity (µS)	286.0	297.0	226.0	151.7	430.0	157.7	147.1	97.8	238.0	253.0
Total dissolved solids (mg/L)	137.6	142.7	108.1	72.3	208.0	75.2	70.1	46.4	113.9	121.5
Salinity (ppt)	0.1	0.1	0.1	0.1	0.2	0.1	0.1	0.0	0.1	0.1
pH	7.5	7.3	7.2	7.3	7.2	7.7	7.2	7.4	7.3	8.4

Appendix Table D-11. Water quality measurements in reaches of Tualatin River tributaries, fall 2000. L = lower reach, M = middle reach, and U = upper reach.

	Stream										
	Summer			Ash			Cedar		Dawson		
	L	M	U	L	M	U	M	U	L	M	U
Turbidity (NTU)	21.3	7.1	13.6	100.1	12.7	32.0	15.3	17.6	8.4	8.6	7.0
Oxygen saturation (%)	41.3	53.3	52.1	29.5	55.6	68.5	46.8	57.2	62.4	51.8	75.7
Dissolved oxygen (mg/L)	4.6	5.62	5.6	3.2	6.2	7.0	5.0	6.24	6.4	5.4	7.8
Temperature (°C)	11.7	13.3	12.5	11.3	11.3	14.2	11.5	11.5	13.5	13.7	13.9
Mean velocity (m/s)	0.7	0.0	0.5	0.0	0.0	1.0	0.0	1.2	0.0	0.0	3.4
Maximum velocity (m/s)	0.9	0.0	0.6	0.0	0.0	1.2	0.0	1.8	0.0	0.0	4.6
Conductivity (µS)	154.0	126.5	162.1	161.3	165.2	81.6	127.2	127.2	244.0	230.0	317.0
Total dissolved solids (mg/L)	73.5	60.2	77.4	77.0	78.9	38.6	60.5	60.5	116.9	110.1	152.6
Salinity (ppt)	0.1	0.1	0.1	0.1	0.1	0.0	0.1	0.1	0.1	0.1	0.2
pH	7.5	--	7.0	6.4	6.4	7.0	6.0	6.5	6.5	7.0	7.0

Appendix Table D-12. Water quality measurements in reaches of Tualatin River tributaries, fall 2000. L = lower reach, M = middle reach, and U = upper reach.

	Stream									
	Beaverton		Bronson		Cedar Mill		Johnson		Council	
	L	M	L	M	M	U	M	U	M	U
Turbidity (NTU)	11.5	17.8	8.2	10.2	12.0	196.3	24.7	5.7	31.1	16.8
Oxygen saturation (%)	62.8	54.4	67.0	69.3	61.2	85.2	25.8	57.8	32.7	37.8
Dissolved oxygen (mg/L)	6.6	5.7	7.15	7.5	7.6	9.0	2.7	6.2	3.4	3.8
Temperature (°C)	13.3	13.6	13.3	11.5	4.3	13.0	14.0	13.0	15.4	13.7
Mean velocity (m/s)	2.1	1.2	0.0	0.8	0.0	2.4	0.0	0.0	0.3	0.0
Maximum velocity (m/s)	3.4	1.7	0.0	1.1	0.7	3.9	0.0	0.0	0.6	0.0
Conductivity (µS)	181.0	202.0	128.6	137.3	477.0	136.8	132.8	114.5	181.7	201.0
Total dissolved solids (mg/L)	86.5	96.5	61.2	65.1	231.0	65.1	63.2	54.4	86.8	96.1
Salinity (ppt)	0.1	0.1	0.1	0.1	0.2	0	0.1	0.1	0.1	0.1
pH	6.0	5.5	6.0	6.6	7.3	0	5.5	7.0	6.0	6.0

Appendix Table D-13. Water quality measurements in reaches of Tualatin River tributaries, winter 2000. L = lower reach, M = middle reach, and U = upper reach.

	Stream										
	Summer			Ash			Cedar		Dawson		
	L	M	U	L	M	U	M	U	L	M	U
Turbidity (NTU)	31.4	10.5	13.1	28.5	9.1	6.7	7.8	8.5	6.5	9.2	6.7
Oxygen saturation (%)	92.3	92.8	99.0	75.6	83.3	87.4	72.4	69.6	78.4	85.3	88.4
Dissolved oxygen (mg/L)	11.4	7.8	6.9	9.4	10.3	11.2	9.1	8.7	9.9	11.1	10.9
Temperature (°C)	7.0	11.3	12.3	5.9	6.3	5.7	5.8	5.7	6.2	5.1	5.7
Mean velocity (m/s)	0.9	0.0	1.2	0.0	0.6	0.7	0.0	0.2	0.3	0.0	1.3
Maximum velocity (m/s)	1.9	0.0	1.7	0.0	1.2	1.5	0.0	0.4	0.2	0.0	2.1
Conductivity (μS)	187.2	184.6	194.3	171.5	164.6	168.3	100.4	77.2	299.0	285.0	284.0
Total dissolved solids (mg/L)	89.5	88.2	92.9	81.9	78.6	80.3	47.6	36.5	143.5	136.9	136.5
Salinity (ppt)	0.1	0.1	0.1	0.5	0.1	0.1	0.1	0.0	0.1	0.1	0.1
pH	9.1	8.8	9.1	8.0	7.9	7.5	8.0	8.2	7.5	8.7	7.6

Appendix Table D-14. Water quality measurements in reaches of Tualatin River tributaries, winter 2000. L = lower reach, M = middle reach, and U = upper reach.

	Stream									
	Beaverton		Bronson		Cedar Mill		Johnson		Council	
	L	M	L	M	M	U	M	U	M	U
Turbidity (NTU)	9.5	20.6	32.7	8.0	16.6	7.4	11.2	35.0	7.2	4.7
Oxygen saturation (%)	80.0	65.6	66.4	93.8	71.4	81.2	45.6	86.7	64.6	85.9
Dissolved oxygen (mg/L)	9.9	8.3	8.0	12.6	9.0	10.3	5.8	11.3	7.2	10.1
Temperature (°C)	5.6	5.8	5.1	3.8	5.7	5.7	6.2	5.0	6.2	7.0
Mean velocity (m/s)	2.0	0.8	0.6	1.6	0.0	1.0	0.0	1.1	0.4	1.3
Maximum velocity (m/s)	3.6	2.1	1.2	2.1	0.0	1.2	0.0	1.3	2.8	2.2
Conductivity (µS)	185.8	161.6	196.1	155.4	206.0	179.9	148.8	87.4	187.5	202.0
Total dissolved solids (mg/L)	88.8	77.1	93.8	74.1	98.8	85.9	70.9	41.4	89.7	96.5
Salinity (ppt)	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.0	0.1	0.1
pH	7.5	8.6	7.9	7.7	8.8	8.1	8.8	9.3	8.0	8.1

Appendix Table D-15. Water quality measurements in reaches of Tualatin River tributaries, spring 2001. L = lower reach, M = middle reach, and U = upper reach.

	Stream										
	Summer			Ash			Cedar		Dawson		
	L	M	U	L	M	U	M	U	L	M	U
Turbidity (NTU)	12.4	7.1	11.5	13.1	8.8	5.1	6.7	6.1	7.7	5.2	6.1
Oxygen saturation (%)	65.2	68.5	7.7	111.1	107.2	101.6	102.1	85.7	73.3	77.8	92.3
Dissolved oxygen (mg/L)	6.3	6.4	7.5	11.3	11.8	10.7	11.8	10.4	8.1	8.5	10.21
Temperature (°C)	17.1	19.1	15.8	14.2	12.7	12.2	8.3	7.5	11.4	11.7	12.5
Mean velocity (m/s)	1.8	0.0	0.9	2.3	0.6	2.9	0.7	2.0	1.4	0.0	1.9
Maximum velocity (m/s)	2.1	0.0	1.3	3.3	0.9	3.5	0.8	2.2	1.5	0.0	2.1
Conductivity (μS)	180.2	216.0	171.5	245.0	186.1	185.9	82.3	64.5	234.0	278.0	257.0
Total dissolved solids (mg/L)	86.1	103.5	81.9	117.4	89.0	88.8	38.9	30.4	112.1	133.4	123.4
Salinity (ppt)	0.1	0.1	0.1	0.1	0.1	0.1	0.0	1.0	0.1	0.1	0.1
pH	7.8	6.7	7.1	7.7	8.0	7.7	8.5	8.0	8.2	8.3	8.0

Appendix Table D-16. Water quality measurements in reaches of Tualatin River tributaries, spring 2001. L = lower reach, M = middle reach, and U = upper reach.

	Stream									
	Beaverton		Bronson		Cedar Mill		Johnson		Council	
	L	M	L	M	M	U	M	U	M	U
Turbidity (NTU)	9.5	9.8	6.4	4.2	7.6	19.3	9.1	10.6	3.5	1.7
Oxygen saturation (%)	72.5	40.7	71.8	92.8	88.5	105.6	31.5	81.9	61.5	57.9
Dissolved oxygen (mg/L)	7.2	3.7	9.3	11.3	9.7	12.6	3.1	8.9	5.6	6.3
Temperature (°C)	15.5	19.7	8.5	7.4	11.6	8.5	15.6	11.1	18.6	12.1
Mean velocity (m/s)	1.2	0.6	0.7	0.7	0.4	1.0	0.0	0.3	0.0	0.0
Maximum velocity (m/s)	1.3	1.0	1.3	0.9	0.4	1.3	0.0	0.8	0.0	0.0
Conductivity (μS)	174.5	205.0	192.0	142.5	194.2	157.2	180.6	105.9	29.2	189.7
Total dissolved solids (mg/L)	83.4	97.9	91.8	67.9	92.9	75.0	86.3	50.3	140.1	90.7
Salinity (ppt)	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1
pH	7.5	7.6	8.1	8.0	8.0	8.9	7.8	8.1	7.3	7.5